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# Wisconsin Tributary Loadings to the Upper Great Lakes

Wisconsin Dept of Natural Resources, Madison

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16. ABSTRACT

Intensity of water quality sampling on four major Wisconsin tributaries was increased to provide data for the International Joint Commission, Upper Lakes Reference Group project entitled "Land Source Inputs to Upper Great Lakes From the U.S." Involved were (1) analysis of water samples from fixed stations on a monthly basis, (2) increased sampling during spring runoff and sampling for an expanded list of parameters three times during the year, and (3) an intensive survey run twice on each river during the summer of 1974. With the exception of localized problems, the data indicates that Lake Superior water off Wisconsin tributaries is of excellent quality and supports diverse and abundant populations of aquatic organisms.

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Environmental Monitoring

# WISCONSIN TRIBUTARY

# LOADINGS TO THE UPPER GREAT LAKES

BY

State of Wisconsin
Wisconsin Department of Natural Resources
Division of Environmental Protection
Box 7921
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## SUMMARY

Intensity of water quality sampling was increased on the Nemadji, Bois Brule, Bad and Montreal Rivers during 1973. Involved were: 1) analysis of water samples from fixed stations on a monthly basis, 2) increased sampling during spring runoff and sampling for an expanded list of parameters three times during the year, and 3) an intensive survey run twice on each river during the summer of 1974. With the exception of localized problems, the data indicates that water is of excellent quality and supports diverse and abundant populations of aquatic organisms.

SUMMARY TRIBUTARY LOADINGS

| PARAMETER | Bad River | | | Bois Brule River | | | Montreal River | | | Nemadji River | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of SAMPLES | Mean Loading (Metric tons/yr) | Standard Deviation for Loading (Metric tons/yr) | No. of SAMPLES | Mean Loading (Metric tons/yr) | Standard Deviation for Loading (Metric tons/yr) | No. of SAMPLES | Mean Loading (Metric tons/yr) | Standard Deviation for Loading (Metric tons/yr) | No. of SAMPLES | Mean Loading (Metric tons/yr) | Standard Deviation for Loading (Metric tons/yr) |
| Alkalinity | 29 | 119,355 | 50,370 | 31 | 15,585.5 | 3,686.5 | 28 | 12,848 | 3,723 | 25 | 98,915 | 39,420 |
| Arsenic | 3 | ND | | 2 | ND | | 3 | ND | | 3 | ND | |
| Barium | 3 | 82.49 | 22.3 | 2 | 8.91 | .56 | 3 | 4.71 | .91 | 33 | 58 | 39.05 |
| BOD | 28 | 8,103 | 12,921 | 30 | 649.70 | 292.73 | 28 | 938.05 | 390.55 | 24 | 3,029.5 | 981.85 |
| Cadmium | 4 | .73 | .95 | 4 | ND | | 4 | .15 | .19 | 4 | 1.88 | 2.31 |
| Calcium | 3 | 2,372.5 | 16,753.5 | 4 | 3,285 | 919.8 | 3 | 4,270.5 | 1,109.6 | 4 | 24,783.5 | 9,052 |
| COD | 4 | 51,465 | 35,368.5 | 4 | 7,592 | 4,672 | 4 | 15,111 | 3,551.45 | 4 | 56,210 | 21,170 |
| Chloride | 25 | 4,854.5 | 18,432.5 | 27 | 243.09 | 511 | 25 | 1,164.35 | 941.7 | 22 | 56,210 | 21,170 |
| Chromium | 4 | 11.17 | 14.05 | 3 | 2.31 | 1.55 | 4 | 1.64 | 1.85 | 4 | 20.73 | 30.73 |
| Copper | 4 | 58.04 | 105.85 | 4 | 1.13 | .92 | 4 | 85.41 | 168.72 | 4 | 21.68 | 24.71 |
| Cyanide | 3 | ND | | 4 | ND | | 4 | 2.5 | 2.77 | 4 | ND | |
| Fluoride | 4 | 375.95 | 138.7 | 5 | 51.1 | 26.32 | 4 | 93.81 | 85.05 | 5 | 211.33 | 55.11 |
| Iron | 24 | 4,416.5 | 5,577.2 | 27 | 196.73 | 196.73 | 25 | 423.4 | 868.7 | 18 | 8,577.5 | 12,045 |
| Lead | 4 | 108.77 | 199.65 | 4 | ND | | 4 | ND | | 4 | 22.23 | 25.29 |
| Magnesium | 3 | 7,154 | 4,964 | 4 | 1,120.55 | 320.47 | 3 | 1,029.3 | 675.25 | 4 | 4,635.5 | 3,149.95 |
| Manganese | 24 | 87.23 | 87.23 | 27 | 7.59 | 3.83 | 24 | 97.82 | 359.89 | 18 | 100.01 | 110.23 |
| Mercury | 4 | .27 | .11 | 3 | .04 | .02 | 4 | .07 | .03 | 4 | .16 | .07 |
| Nickel | 4 | ND | | 4 | 2.08 | .76 | 4 | ND | | 4 | 21.5 | 21.17 |
| Nitrogen, Ammonia | 29 | 175.2 | 130.31 | 30 | 21.57 | 16.72 | 28 | 48.18 | 36.87 | 24 | 149.65 | 111.69 |
| Nitrogen, Kjeldahl | 29 | 1.10 | 448.95 | 30 | 131.4 | 56.21 | 28 | 267.91 | 69.35 | 23 | 930.75 | 344.92 |
| Nitrogen, Nitrate+Nitrite | 19 | 279.95 | 208.05 | 15 | 27.34 | 13.29 | 17 | 91.61 | 45.63 | 20 | 194.91 | 125.56 |
| Nitrogen, Organic | 29 | 927.1 | 423.4 | 31 | 108.04 | 53.65 | 28 | 220.09 | 71.91 | 24 | 751.9 | 363.91 |
| Nitrogen, Total | 19 | 1,379.7 | 514.65 | 14 | 178.49 | 72.63 | 17 | 339.45 | 100.01 | 18 | 1,749.75 | 423.4 |
| Oil-Grease | 1 | ND | | 1 | ND | | 1 | ND | | 1 | Nd | |
| Pesticide, Aldrin | 3 | ND | | 3 | ND | | 3 | ND | | 3 | ND | |
| Pesticide, DDD | 4 | ND | | 4 | ND | | 4 | ND | | 4 | ND | |
| Pesticide, DDE | 4 | ND | | 4 | ND | | 4 | ND | | 4 | ND | |
| Pesticide, DDT | 4 | .0073 | .0037 | 4 | ND | | 4 | ND | | 4 | ND | |
| Pesticide, Dieldrin | 4 | ND | | 4 | ND | | 4 | ND | | 4 | ND | |
| Pesticide, Heptachlor | 4 | ND | | 4 | ND | | 4 | ND | | 4 | ND | |
| Pesticide, Heptachlor Epoxide | 4 | ND | | 4 | ND | | 4 | ND | | 4 | ND | |
| Pesticide, Lindane | 4 | ND | | 4 | ND | | 4 | ND | | 4 | ND | |
| Phenols | 27 | 8.54 | 5.33 | 27 | 1.555 | | 24 | 2.61 | 2.32 | 19 | 9.13 | 12.23 |
| Phosphorus, Total | 29 | 171.55 | 153.3 | 31 | 19.137 | | 28 | 37.23 | 13.54 | 25 | 256.59 | 303.68 |
| Phosphorus, Soluble | 23 | 48.55 | 38.69 | 24 | 6.9 | | 17 | 14.51 | 34.77 | 23 | 32.52 | 23.03 |
| Phthalates, Diethyl Hexyl | 4 | ND | | 4 | ND | | 4 | ND | | 4 | ND | |
| Polychlorinated Biphenyl | 4 | ND | | 4 | ND | | 4 | ND | | 4 | .12 | .19 |
| Potassium | 3 | 2,361.55 | 372.3 | 4 | 304.41 | 32.05 | 3 | 536.55 | 299.3 | 4 | 2,941.9 | 879.65 |
| Selenium | 3 | 4.85 | 5.26 | 2 | ND | 5.26 | 3 | ND | | 3 | ND | |
| Silica | 27 | 22,228.5 | 7,446 | 27 | 4,197.5 | 5,183 | 27 | 2,817.8 | 1,259.25 | 21 | 14,052.5 | 4,088 |
| Sodium | 3 | 4,307 | 2,529.45 | 4 | 711.75 | 105.85 | 3 | 1,146.1 | 540.2 | 4 | 3,504 | 1,898 |
| Solids Total | 27 | 390,550 | 228,855 | 29 | 34,310 | 8,249 | 27 | 39,785 | 7,774.5 | 25 | 459,900 | 331,785 |
| Solids, Total Dissolved | 24 | 202,940 | 72,635 | 26 | 52,195 | 80,300 | 24 | 43,435 | 54,750 | 19 | 332,880 | 540,200 |
| Solids Total Suspended | 28 | 159,505 | 245,280 | 31 | 6,679.5 | 5,402 | 28 | 3,544.15 | 3,401.8 | 24 | 234,695 | 337,260 |
| Sulfate | 1 | 10,731 | NA | 2 | 1,281.15 | 0 | 1 | 4,415.5 | NA | 2 | 1,321.3 | 0 |
| Zinc | 4 | 77.75 | 66.62 | 4 | 7.3 | 5.99 | 4 | 9.38 | 8.5 | 4 | 97.45 | 96.98 |

# INTRODUCTION

## Objectives

In cooperation with the International Joint Commission and the Upper Great Lakes Reference Group and supplemental support from the Environmental Protection Agency, the Wisconsin Department of Natural Resources increased surveillance and investigation on major Wisconsin tributaries to Lake Superior during 1973. Primary sampling stations were established on the Bois Brule, Bad and Montreal Rivers during July of 1973 and the Nemadji River station was added to the program in January of 1974.

The three basic phases of this program included the following:

1. The collection of monthly water samples for chemical analysis from the primary station on each of the four rivers. These primary stations are shown and described on Figures N-1, Br-1, Ba-1 and M-1. It is expected that this phase of the program will be continued under the State of Wisconsin Primary Station Monitoring Program after termination of the relatively short-term IJC study.

   Summary data sheets of the information collected during monthly monitoring are included in Appendix A attached to this report.

2. Special procedures for sampling at the primary stations called for an additional four samples during the spring runoff period and sampling for an expanded list of parameters three times during the year.

   Data collected during this phase is also included in the summary data sheets in Appendix A.

3. Great Lakes Reference Study: Study Item V - Local Effects. A subsection of Study Item V outlined an additional and more intensive survey to be run twice on each of the tributaries during the summer of 1974. Sampling at several stations along the course of each river and in Lake Superior in the vicinity of the river mouths was involved. This report provides results and discussion of local effects of these rivers.

## Description of Study Area

The four streams involved in this study are the Nemadji, Bois Brule, Bad and Montreal Rivers. All are major streams draining into Lake Superior but differ widely in character.

The Nemadji River originates in Minnesota and flows across northwest Douglas County. The river drains a fairly large watershed (475 square miles) of which 215 square miles are in Douglas County. The 7Q10 low flow at the United States Geological Survey gaging station is 49 cubic feet per second. A highly varied

population of fish and aquatic life inhabits the stream. The Nemadji River watershed is a geologically young area with soil erosion processes occurring naturally at a rapid rate. The main channel and tributaries have dissected the area forming deep ravines. Unstable red clay soils found throughout the watershed erode easily and are subject to slippage along field gullies, roads, railroad cuts and stream banks. In-stream sedimentation, a direct result of erosion, is a serious management problem. Siltation also causes navigation problems in the Duluth-Superior Harbor. The U.S. Army Corps of Engineers continually dredges channels to allow navigation by Great Lakes and ocean-going freighters. Only five percent of the watershed land cover is used for agricultural purposes. This limited land use occurs along the flat ridge tops separating tributaries. The remaining land area is wild forested land (Sather and Johannes, 1972).

The Bois Brule is one of Wisconsin's most famous trout streams. It is approximately 44 miles in length and flows northward along the eastern border of Douglas County into Lake Superior. The river falls a total of 420 feet from its headwaters to Lake Superior. In the upper 26 miles the Brule flows through a broad, flat wilderness bog valley rich in springs. The elevation change in this reach is only 92 feet, an average fall of 3 feet per mile. Below Cedar Island, the river passes through a series of natural shallow lakes formed behind glacial till barriers in the bed of the stream. In this area, the river valley begins to narrow and the bog shoreline changes to firm upland. The gradient increases greatly in this reach. The lower 18 miles has a fall of 328 feet, an average drop of 17 feet per mile. From County Highway B downstream past the ranger station, the river becomes a series of short rapids. The stretch between U.S. Highway 2 and the Copper Range Campground is referred to as the "meadows." Here, the flow is slower and many deep pools provide excellent in-stream cover. From the campground to Lake Superior the river drops very sharply, forming an almost continuous rapids. The river valley in this stretch is narrow with steep, often times exposed red clay banks. Rock riprapping along the toes of these clay slip banks have been moderately successful in stabilizing banks and controlling erosion (Sather and Johannes, 1972).

The Bad River is the main drainage stream of Ashland County and at 70 miles, also the longest. The upper reach of the stream, from the headwaters to Cayuga, has a moderate gradient. Above Mellen, there is a diversion structure which supplies water to a public utility power station of the Lake Superior District Power Company. The impounded area behind this structure is not large enough to be termed a flowage. The middle reach of the river, in the Mellen area, flows through bedrock and boulders. This reach has many rapids and waterfalls, including Copper Falls and Brownstone Falls north of Mellen. The downstream reach of the Bad River is broad and sluggish with a low gradient. Only two lakes are present directly on the river - Caroline Lake and the Bad River Slough. A large number of streams flow into the river, including the White, Potato, Marengo and Tyler Forks Rivers (Sather and Threinen, 1966).

The Montreal River forms the boundary between Michigan and Wisconsin along much of its length. The river is a soft water stream with slightly alkaline, medium brown water. The entire stream is classified as trout water and is inhabited by brook trout, brown trout and some rainbows.

Stream gradient is about 34 feet per mile. Stream flow is controlled by three hydroelectric impoundments - the Superior Falls Flowage and the Saxon Falls Flowage on the main stem, and the Gile Flowage on the West Fork. Flow at the gaging station upstream from the Superior Falls Flowage is extremely variable ranging from 2 to 6,000 cubic feet per second. Flow at this station exceeds 147 cfs 70 percent of the time, but low flow is a problem at certain times. The watershed is predominantly wooded or wild land with 10 to 15 percent exhibiting cleared, agricultural or urban land use (Andrews and Threinen, 1969).

Survey Method

Sampling stations were established at several locations on each stream and adjacent to river mouths (see maps). Two sampling runs were planned, one to reflect spring runoff conditions and the other during normal low flow conditions. Ice conditions prevented sampling on the lake during the peak runoff period, so the first sampling involved only stream stations. Two additional surveys were run including both stream and lake stations.

At each station, field measurements were taken of temperature, pH and dissolved oxygen. Colorimetric comparison was used to measure pH values (Rascher and Betzold pH kit). Temperature and D.O. were measured either by a standard laboratory-grade mercury thermometer and the modified Winkler wet-chemical procedure or through use of an electric temperature-oxygen meter (Yellow Springs Instrument Company Model No. 54 RC). Water samples for chemical analysis were collected in polyethylene containers and submitted to the State Lab of Hygiene for analysis.

Benthological samples for the analysis of macroinvertebrate communities were collected using a variety of techniques. At the river stations, both bottom dredge samples and random hand collections from rocks and debris were utilized to assure sampling from the variety of habitat conditions encountered. River mouth and lake bottom samples were collected using either the Holman or Peterson dredges in an effort to obtain quantitative results.

## SURVEY FINDINGS

General chemical analysis results obtained during the survey period are summarized in Tables N-1, Br-1, Ba-1 and M-1. Metals analysis were not obtained during every sample period and a reduced number of stations were involved. The metals data is summarized in Tables N-2, Br-2, Ba-2 and M-2.

Benthological data for this study is expressed in a series of map-graphs for each river involved. These figures also locate the sites of the sampling stations involved.

Nemadji River

One of the most striking characteristics of the Nemadji River is the high solids load carried during spring runoff. This would have to be considered

an expected result because of the abundance of red clay in this watershed. It is unfortunate that lake sampling could not have been conducted during this period to document the extent of lake influence.

An indication of the trophic nature of Superior Bay is reflected in the nutrient data. Although the concentrations of the major nutrients (nitrogen and phosphorus) carried in the Nemadji River are fairly high, the nutrient levels in the bay are substantially higher. This situation is almost certainly the result of municipal and industrial pollution presently being introduced into the St. Louis River, St. Louis Bay and Superior Bay.

Several of the parameters in Table N-1 show that the nutrient and contaminant load is considerably lessened at the three stations (IX, X and XI) outside of Wisconsin and Minnesota points. These stations are located in Lake Superior proper but still definitely show signs of being influenced by the contaminant loading outflowing from Superior Entry.

Biological sampling of the Nemadji River revealed the development of normal stream benthic communities at the three upstream stations (Figure N-1). Intolerant organisms such as stonefly nymphs, mayfly nymphs and caddis fly larvae were well represented and the total benthic community was varied and relatively sparse.

The downstream station at Highway 2-53 shows the change in the river character as it nears Lake Superior. This station is only about 1/2 mile from the river mouth and the stream is wide, slow-moving and relatively deep. The benthic community of sludgeworms (Oligochaeta) with representatives of midge larvae (Chironomidae) and mayfly nymphs (Hexagenia sp.) is probably representative of the general habitat conditions and some response to cultural pollution as the river flows through the City of Superior.

The biological survey of the Superior Harbor area (Figure N-2) graphically illustrates the organic pollution level of this area. This benthic community is dominated by very tolerant sludgeworms (Oligochaeta) and tolerant diptera larvae (primarily midges - Chironomidae). Station I is located in the mouth of the Nemadji River but the characteristics of this area could perhaps best be described as a freshwater estuary environment. The water movement in this area is influenced by wind seiches and other movements of Lake Superior. Therefore, this station cannot be considered as truly representative of Nemadji River water quality.

Stations III and IV on the east end of the Superior Harbor Basin were the only stations where significant numbers of intolerant organisms were found. The occurrence of mayfly nymphs (Hexagenia sp) caddisfly larvae (Phylocentropus sp.) and fingernail clams (Sphaeriidae) in this area may be a response to the relatively clean water of Allouez Bay.

Table N-2 documents the metals concentrations found during this investigation. With only a few exceptions the levels were well below recommendations from the EPA publication, Water Quality Criteria, 1972. The .13 mg/l of lead found at Highway W is especially high with no explanation at this time. One station (I) also showed a slightly high mercury level. Resampling of these stations will be undertaken as time permits.

TABLE N-1

RESULTS OF GENERAL CHEMISTRY ANALYSIS
Nemadji River-Lake Superior

| PARAMETER | Date 1974 | River Stations(1) Hwy W | Hwy 35 | Hwy C | Hwy 2-53 | Lake Stations(2) I | II | III | IV | V | VI | VII | VIII | IX | X | XI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MFCC | 4/18 | 3900 | 3700 | 3700 | 5100 | (3) | | | | | | | | | | |
| (No./100 ml.) | 6/18 | 500 | 500 | 600 | 3900 | 500 | 500 | 100 | 200 | | <100 | <100 | 100 | | | |
| | 9/11 | <100 | 50 | 100 | 1600 | 1800 | 300 | 100 | 100 | 1600 | 900 | 900 | 400 | <100 | <100 | |
| MFFCC | 4/18 | 20 | 30 | 30 | 400 | | | | | | | | | | | |
| (No./100 ml.) | 6/18 | 20 | 20 | 20 | 420 | 50 | 50 | <10 | 20 | | 10 | <10 | 10 | | | |
| | 9/11 | 10 | 10 | 30 | 80 | 130 | 10 | 30 | 10 | 30 | 20 | 80 | <10 | <10 | 10 | |
| BOD | 4/18 | 4.9 | 4.9 | 3.3 | 2.5 | | | | | | | | | | | |
| (5-day) | 6/18 | 2.5 | 2.5 | 2.0 | 2.0 | 2.5 | 2.5 | 2.5 | 3.3 | 3.3 | 2.9 | 2.9 | 2.9 | | | |
| | 9/11 | 1.6 | 2.5 | 2.9 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 3.3 | 2.9 | 2.0 | 2.9 | 2.5 | 2.5 | 2.0 |
| Total Solids | 4/8 | 1200 | 1122 | 1350 | 1440 | | | | | | | | | | | |
| | 6/18 | 170 | 184 | 210 | 174 | 148 | 142 | 132 | 128 | 122 | 128 | 132 | 130 | | | |
| | 9/11 | 158 | 172 | 180 | 214 | 190 | 112 | 102 | 108 | 116 | 212 | 136 | 106 | 52 | 86 | 78 |
| Susp. Solids | 4/18 | 1025 | 932 | 1155 | 1330 | | | | | | | | | | | |
| | 6/18 | 47 | 75 | 85 | 39 | 21 | 10 | 12 | 10 | 8 | 8 | 8 | 7 | | | |
| | 9/11 | 6 | 12 | 14 | 17 | 21 | 9 | 11 | 12 | 9 | 6 | 10 | 10 | 0 | 8 | 10 |
| Vol Susp. Solids | 4/18 | 30 | 48 | 50 | 60 | | | | | | | | | | | |
| | 6/18 | 3 | 5 | 4 | 1 | 5 | 0 | 3 | 2 | 3 | 2 | 1 | 1 | | | |
| | 9/11 | 0 | 2 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 2 | 3 | 1 | 0 | 1 | 1 |
| Tot. Org. N. | 4/18 | 1.18 | .96 | .91 | .94 | | | | | | | | | | | |
| | 6/18 | .61 | .66 | .62 | .65 | .72 | .82 | .82 | .89 | .89 | .92 | .88 | .86 | | | |
| | 9/11 | .30 | .34 | .37 | .37 | .41 | .57 | .47 | .45 | .56 | .58 | .56 | .47 | .15 | .34 | .26 |
| Nitrate N. | 4/18 | .13 | <.10 | .10 | .05 | | | | | | | | | | | |
| | 6/18 | .01 | .01 | .01 | <.01 | .05 | .04 | .03 | .03 | .03 | .02 | .02 | .03 | | | |
| | 9/11 | .04 | .03 | .06 | .04 | .04 | .23 | .22 | .19 | .21 | .20 | .19 | .21 | .15 | .24 | .22 |
| Nitrite N | 4/18 | .015 | .015 | .013 | .013 | | | | | | | | | | | |
| | 6/18 | .007 | .007 | .006 | .007 | .012 | .01 | .013 | .012 | .01 | .01 | .009 | .01 | | | |
| | 9/11 | .001 | .001 | .001 | .001 | .003 | .017 | .012 | .011 | .016 | .016 | .023 | .012 | .002 | .008 | .005 |

6/8/76
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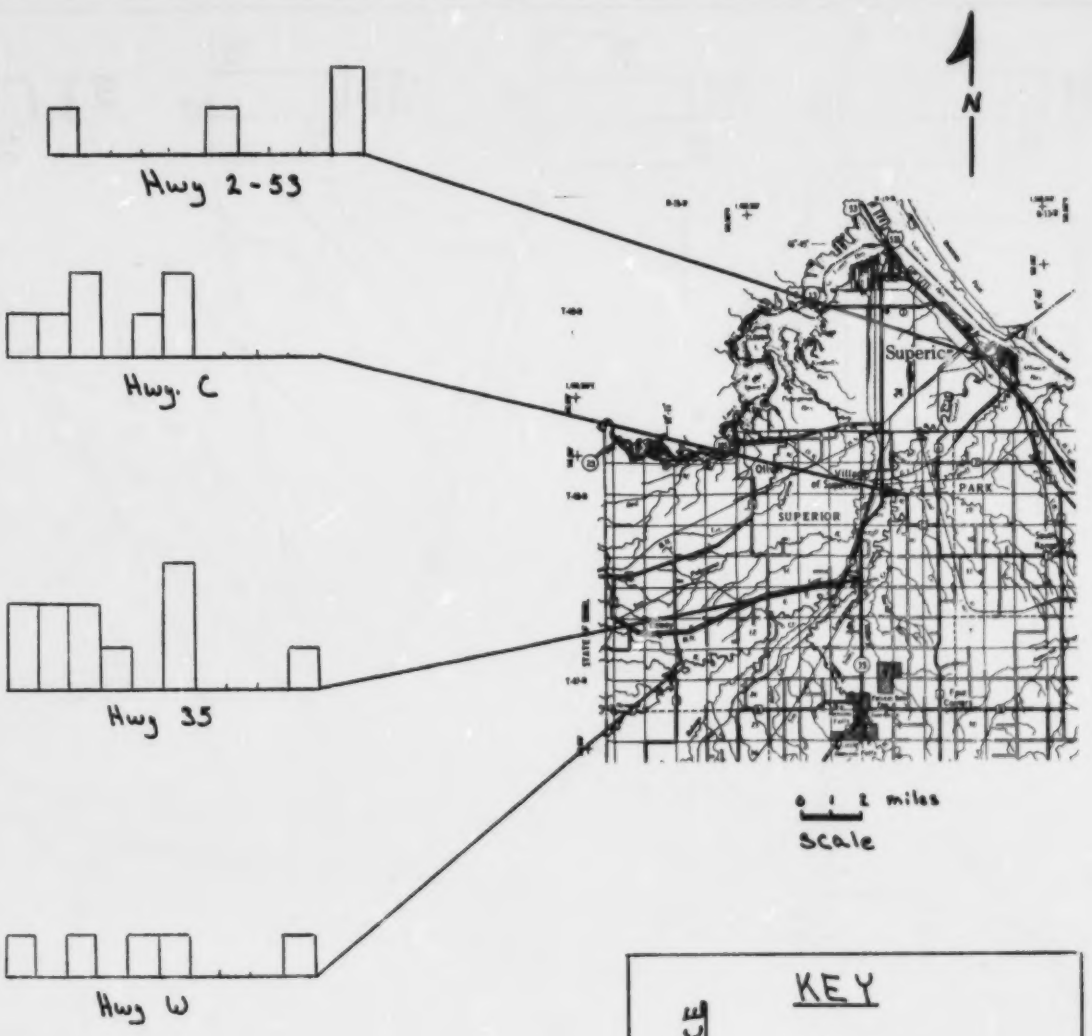
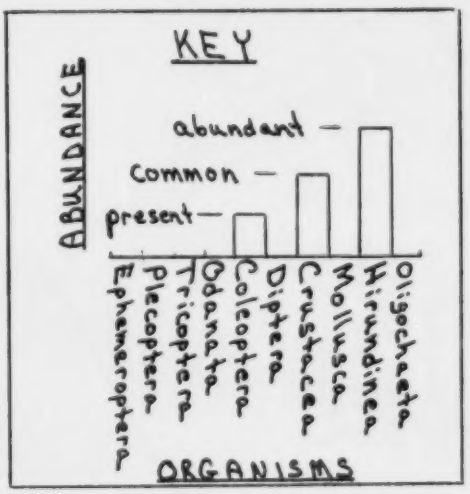
| Table N-1 Continued: | Date 1974 | Hwy W | Hwy 35 | Hwy C | Hwy 2-53 | I | II | III | IV | V | VI | VII | VIII | IX | X | XI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $NH_3$-N | 4/18 | .14 | .12 | .13 | .19 | | | | | | | | | | | |
| | 6/18 | .03 | .04 | .03 | .07 | .13 | .14 | .17 | .18 | .19 | .18 | .23 | .19 | | | |
| | 9/11 | .02 | .02 | <.01 | <.01 | .03 | .19 | .13 | .11 | .20 | .20 | .43 | .15 | .01 | .08 | .05 |
| Sol. Phos. | 4/18 | .026 | .028 | .028 | .034 | | | | | | | | | | | |
| | 6/18 | .038 | .024 | .012 | .018 | .038 | .036 | .046 | .050 | .034 | .034 | .030 | .034 | | | |
| | 9/11 | .024 | .008 | .008 | .011 | .014 | .043 | .038 | .037 | .051 | .048 | .046 | .038 | .001 | .019 | .012 |
| Tot. Phos. | 4/18 | .73 | .69 | .86 | 1.10 | | | | | | | | | | | |
| | 6/18 | .24 | .09 | .10 | .07 | .08 | .09 | .09 | .09 | .10 | .09 | .10 | .09 | | | |
| | 9/11 | .03 | .16 | .04 | .04 | .05 | .09 | .07 | .09 | .10 | .10 | .10 | .07 | .01 | .05 | .04 |
| Alkalinity Total ($CaCO_3$) | 4/18 | 44 | 48 | 44 | 48 | | | | | | | | | | | |
| | 6/18 | 58 | 54 | 60 | 66 | 50 | 42 | 46 | 44 | 42 | 40 | 40 | 40 | | | |
| | 9/11 | 104 | 110 | 112 | 118 | 110 | 54 | 52 | 50 | 52 | 56 | 58 | 50 | 42 | 48 | 42 |
| Silica | 6/18 | 7.2 | 6.5 | ≤7.2 | 6.5 | 6.1 | 5.7 | 5.7 | 5.7 | 5.4 | 5.6 | 5.5 | | | | |
| | 9/11 | 11.0 | 10.0 | 11.2 | 10.0 | 10.0 | 3.8 | 3.6 | 3.8 | 3.8 | 2.8 | 3.6 | 3.2 | 2.0 | 2.7 | 2.4 |
| Chlorides | 6/18 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 3.0 | 2.0 | | | |
| | 9/11 | 2.0 | 1.0 | 2.0 | 5.0 | 1.0 | 6.0 | 3.0 | 4.0 | 6.0 | 6.0 | 7.0 | 4.0 | <1.0 | 2.0 | <1.0 |
| Hardness | 4/18 | 68 | 64 | 76 | 68 | | | | | | | | | | | |
| | 6/18 | 68 | 66 | 74 | 77 | 62 | 58 | 56 | 54 | 52 | 52 | 52 | 52 | | | |
| | 9/11 | 117 | 116 | 124 | 124 | 116 | 63 | 60 | 56 | 60 | 60 | 64 | 56 | 44 | 52 | 52 |
| Temp. (°C) | 4/18 | 2 | 3 | 3 | 3 | | | | | | | | | | | |
| | 6/18 | 13 | 13 | 13 | 15 | 15 | 16 | 17 | 17 | 16 | 16 | 16 | 16 | | | |
| | 9/11 | 13 | 15 | 15 | 15 | 14 | 14 | 13 | 13 | 13 | 13 | 13 | 12 | 12 | 12 | 12 |
| D.O. | 4/18 | 12.6 | 12.8 | 12.6 | 12.6 | | | | | | | | | | | |
| | 6/18 | 10.4 | 9.8 | 9.4 | 8.5 | 8.2 | 7.1 | 7.8 | 7.6 | 7.7 | 7.8 | 8.0 | 7.9 | | | |
| | 9/11 | 10.8 | 10.3 | 9.4 | 8.2 | 8.5 | 9.3 | 9.5 | 9.6 | 9.4 | 9.5 | 9.3 | 9.7 | 11.2 | 10.2 | 10.2 |
| pH (S.U.) | 4/18 | 7.4 | 7.4 | 7.5 | 7.4 | | | | | | | | | | | |
| | 6/18 | 7.4 | 7.4 | 7.4 | 7.2 | 7.2 | 7.3 | | 7.1 | 7.2 | 7.0 | 7.0 | 7.1 | | | |
| | 9/11 | 8.0 | 7.8 | 7.8 | 7.6 | 7.6 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.3 | 7.4 | 7.4 | 7.4 |
| Turbidity (N.T.U.) | 6/18 | 26 | 32 | 41 | 28 | 25 | 17 | 19 | 13 | 5.2 | 5.2 | 6.1 | 4.7 | | | |
| | 9/11 | 8.3 | 17 | 16 | 19 | 26 | 7.3 | 13 | 16 | 7.5 | 5.8 | 8.7 | 9.9 | 1.1 | 5.5 | 8.3 |
| Secchi Disk (Feet) | 6/18 | | | | | 1.0 | 1.5 | 1.8 | 1.8 | 2.3 | 2.0 | 1.8 | 2.3 | | | |
| | 9/11 | | | | | 1.8 | 2.4 | 1.8 | 1.8 | 2.1 | 2.6 | 2.0 | 1.9 | 11.2 | 2.9 | 2.2 |

All values in mg/l except where specified
(1) Refer to Figure N - 2
(2) Refer to Figure N - 3
(3) Blank spaces indicate data not collected on that date.




BENTHIC FAUNA OF THE NEMADJI RIVER

18 June 1974

Figure N-1

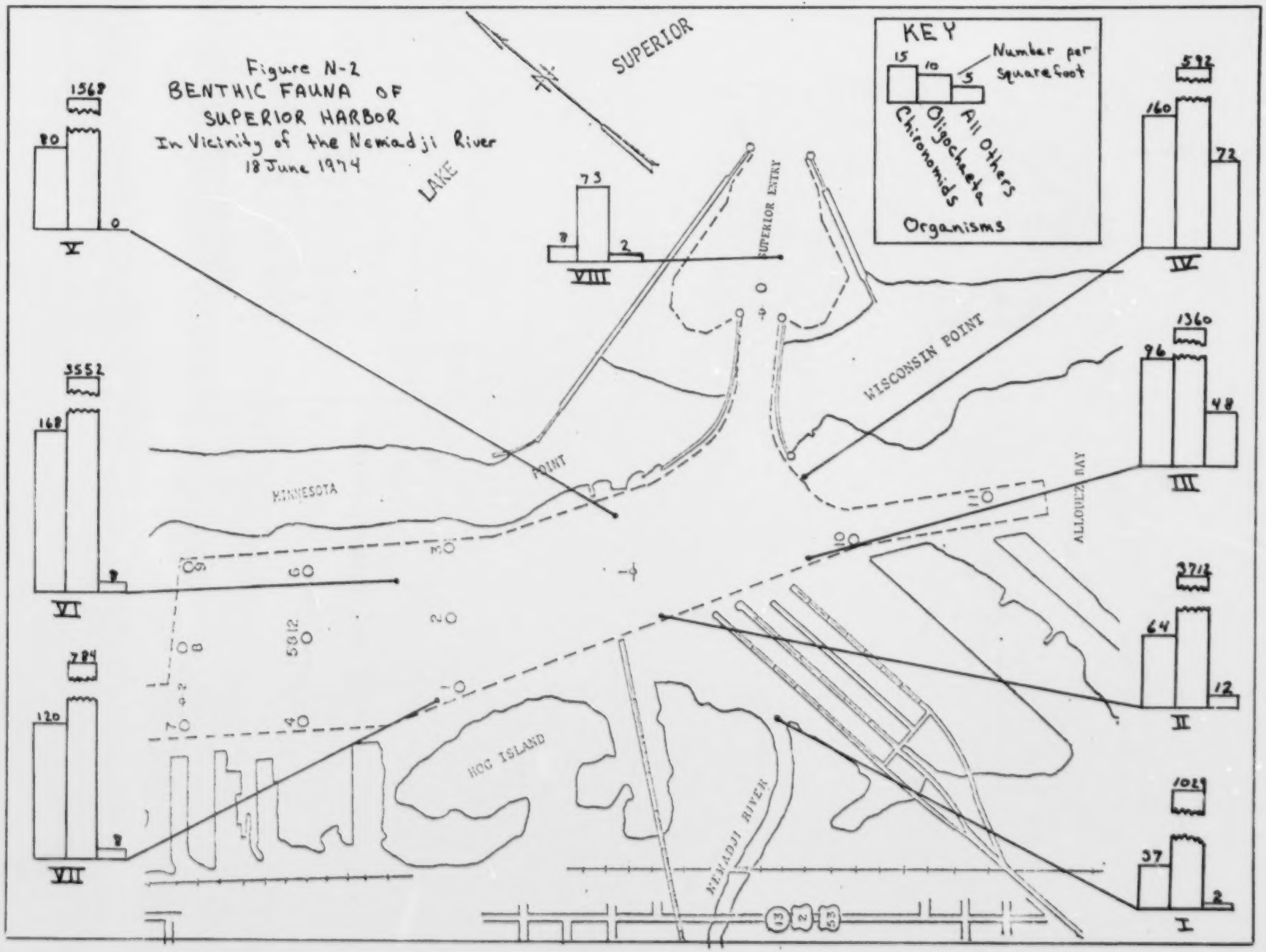


Figure N-2
BENTHIC FAUNA OF
SUPERIOR HARBOR
In Vicinity of the Nemadji River
18 June 1974
KEY
15
10
5
Number per square foot
Chironomids
Oligochaeta
All Others
Organisms
SUPERIOR
LAKE
SUPERIOR ENTRY
WISCONSIN POINT
MINNESOTA POINT
ALLOUEZ BAY
HOG ISLAND
NEMADJI RIVER
1568
80
0
V
73
8
2
VIII
592
160
72
IV
1360
96
48
III
3552
168
8
VI
5312
2784
120
8
VII
2712
64
12
II
1029
37
2
I

TABLE N- 2

METALS CONCENTRATIONS FROM THE NEMADJI RIVER-LAKE SUPERIOR
DURING 1974

| Station[1] | Date | Metals | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Cd | Cr | Cu | Pb | Hg | Ni | Zn |
| Hwy W | 4/18 | <.002 | .09 | .04 | .13 | <.0002 | .06 | .088 |
| Hwy 35 | 4/18 | <.002 | .045 | .037 | .04 | <.0002 | .04 | .075 |
| Hwy C | 2/14 | .0002 | .0012 | .0006 | <.002 | <.0002 | <.01 | <.02 |
| | 4/18 | .002 | .05 | .043 | .04 | <.0002 | .04 | .17 |
| | 7/22 | .004 | .01 | .015 | <.05 | <.0002 | .01 | .04 |
| Hwy 2-53 | 4/18 | <.002 | .055 | .046 | .03 | <.0002 | .05 | .088 |
| Sta. I | 6/18 | <.002 | .01 | .005 | .01 | .0003 | <.01 | .02 |

All values in mg/l

(1) Refer to Figures N-2 and N-3

Bois Brule River

The Bois Brule River has a reputation as an excellent clean water trout stream and the results of this survey tend to bear this out. General water chemistry analyses reveal excellent water quality characteristics (Table Br-1).

The total solids loading does reflect an increase at the lower stations when the river enters the red clay area. However, the concentration only reaches about 1/10th that of the Nemadji River.

An attempt to evaluate the extent of influence on Lake Superior water quality by the Brule River is shown in Table Br-3. In this table the average concentrations of selected parameters is compared for the river mouth station, those stations closest to the mouth (I, II, III and V) and the four stations furthest from the mouth (IV, VI, VII and VIII). Only data from the 6/20 and 9/16 sampling dates was used when collections were made from all sites involved.

Most of the chemical parameter analysis data seems to show a gradual decrease in concentration with distance from the river mouth. However, the turbidity and Secchi disk readings do not follow this pattern. A personal observation during the 9/16 survey would support the secchi disk data, in that the river was visibly less turbid than the near shore lake stations. A probable explanation for this situation would be the significant lake shore erosion taking place on the unstable south shore red clay banks. This problem is undoubtedly "worse" than normal because of the high water level presently being maintained in Lake Superior.

The unusual turbidity readings may possibly be explained by a change in laboratory techniques. During June of 1974, the Wisconsin State Lab of Hygiene implemented the use of a new turbidimeter. The change to this new technique may have resulted in some analysis error. Another potential for error may be the unsuitability of the silicon dioxide method (J.T.U. and N.T.U.) to accurately respond to clay turbidity.

The benthological survey findings as shown in Figures Br-1 and Br-2 again reflect the general high quality of the Bois Brule River. All of the stream stations exhibit a richly diversified benthic fauna indicative of a normal clean water environment.

Sampling difficulties were encountered in attempting to obtain benthic dredge samples near the mouth of the Brule. Our Peterson dredge lacked the necessary extra weights to efficiently penetrate the hard packed sand bottom. The findings of benthic organisms at Station IX (Figure Br-2) is primarily a response to physical habitat conditions in the protected river mouth and should not be considered as a water quality indication in a strict comparison with the lake stations (I - VIII).

The findings of midge larvae (Chironomidae), sludgeworms (Oligochaeta) and mayfly nymphs (Hexagenia sp. and Paraloeptophlebia sp.) at Stations I and II does seem to indicate a slight enrichment factor from the Brule River water. This enrichment factor appears to be extremely localized but this is difficult to interpret because of the aforementioned sampling difficulties.

The metals concentrations found during the Brule River survey (Table Br-2) were quite low and with one exception, well below the recommended levels published in Water Quality Criteria, 1972. The one exception was mercury. Although the mercury concentrations found were low, two stations were shown as having levels over the 0.2 ug/l criteria as recommended by EPA. This condition is not considered a serious problem but resampling will be done to collect more data.

TABLE Br-1

RESULTS OF GENERAL CHEMISTRY ANALYSIS

Bois Brule River-Lake Superior

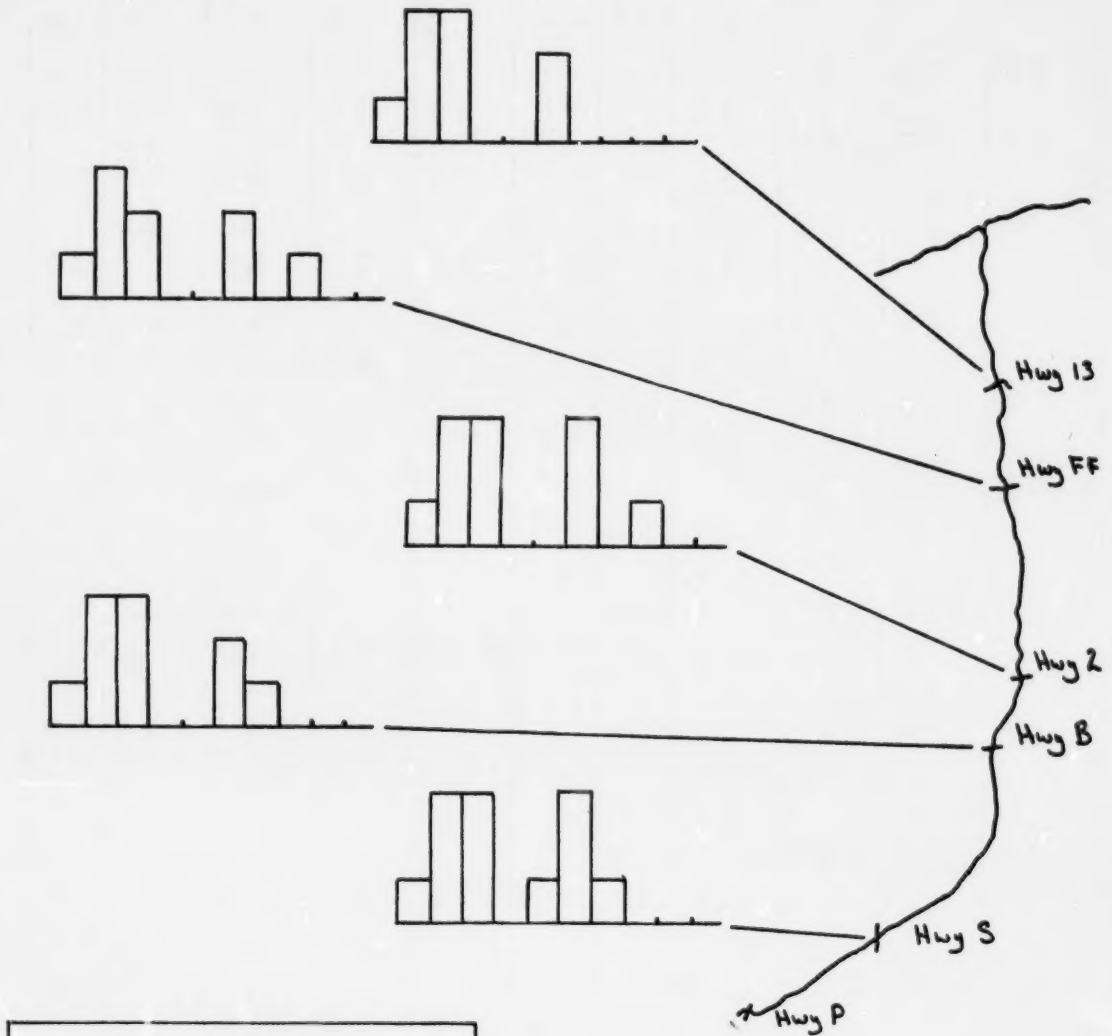
| PARAMETER | Date 1974 | River Stations(1) Hwy S | Hwy B | Hwy 2 | Hwy FF | Hwy 13 | Mouth IX | Lake Stations(2) I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MFCC | 4/18 | 1200 | 200 | 300 | 300 | 1100 | 800 | | | | | | | | |
| (No./100 ml) | 6/20 | 300 | 100 | 800 | 900 | 1200 | 1700 | 1000 | 200 | 100 | 200 | 300 | 100 | 100 | 100 |
| | 9/16 | 740 | 200 | 550 | 360 | 810 | 760 | 90 | 20 | 30 | 30 | 10 | 10 | 10 | 10 |
| MFFCC | 4/18 | 10 | 10 | 10 | 10 | 10 | 20 | | | | | | | | |
| (No./100 ml) | 6/20 | 20 | 20 | 130 | 20 | 40 | 20 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | 9/16 | 10 | 10 | 140 | 10 | 200 | 20 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| BOD | 4/18 | 3.3 | 2.9 | 2.5 | 2.5 | 3.3 | 2.5 | | | | | | | | |
| (5 day) | 6/20 | 2.5 | 2.5 | 2.9 | 2.9 | 2.5 | 2.9 | 2.9 | 2.9 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 2.9 |
| | 9/16 | 1.2 | 1.6 | 1.6 | 1.6 | 1.2 | 1.6 | 1.2 | 1.2 | 1.2 | 1.6 | 1.2 | 1.6 | 1.2 | 1.6 |
| Total Solids | 4/18 | 70 | 96 | 86 | 114 | 140 | 146 | | | | | | | | |
| | 6/20 | 68 | 68 | 96 | 110 | 98 | 88 | 100 | 92 | 96 | 96 | 100 | 94 | 88 | 72 |
| | 9/16 | 58 | 62 | 56 | 98 | 78 | 124 | 86 | 58 | 90 | 66 | 82 | 84 | 62 | 68 |
| Susp. Solids | 4/18 | 15 | 14 | 18 | 41 | 70 | 80 | | | | | | | | |
| | 6/20 | 3 | 6 | 6 | 15 | 20 | 19 | 13 | 5 | 5 | 6 | 9 | 7 | 4 | 7 |
| | 9/16 | 2 | 3 | 5 | 5 | 10 | 49 | 6 | 8 | 24 | 10 | 19 | 8 | 5 | 13 |
| Vol. Susp. Solids | 4/18 | 8 | 4 | 2 | 2 | 5 | 2 | | | | | | | | |
| | 6/20 | 3 | 5 | 5 | 7 | 7 | 5 | 5 | 4 | 4 | 5 | 4 | 3 | 3 | 3 |
| | 9/16 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 |
| Total Org. N. | 4/18 | .65 | .34 | .41 | .53 | .58 | .62 | | | | | | | | |
| | 6/20 | .26 | .28 | .30 | .36 | .42 | .40 | .40 | .38 | .46 | .43 | .34 | .37 | .38 | .43 |
| | 9/16 | .04 | .08 | .05 | .05 | .00 | .15 | .10 | .12 | .10 | .00 | .04 | .18 | .00 | .04 |
| Nitrate N. | 4/18 | .19 | .11 | .16 | .25 | .11 | .13 | | | | | | | | |
| | 6/20 | .11 | .06 | .09 | .11 | .12 | .12 | .21 | .25 | .22 | .24 | .20 | .22 | .24 | .24 |
| | 9/16 | .04 | .02 | .27 | .02 | .02 | .26 | .01 | .27 | .26 | .26 | .27 | .03 | .27 | .27 |
| Nitrite N. | 4/18 | .006 | .003 | .005 | .006 | .007 | .009 | | | | | | | | |
| | 6/20 | .003 | .002 | .003 | .004 | .005 | .005 | .006 | .007 | .008 | .007 | .006 | .007 | .007 | .007 |
| | 9/16 | .001 | .001 | .004 | .001 | .001 | .004 | .001 | .003 | .004 | .005 | .005 | .002 | .003 | .004 |

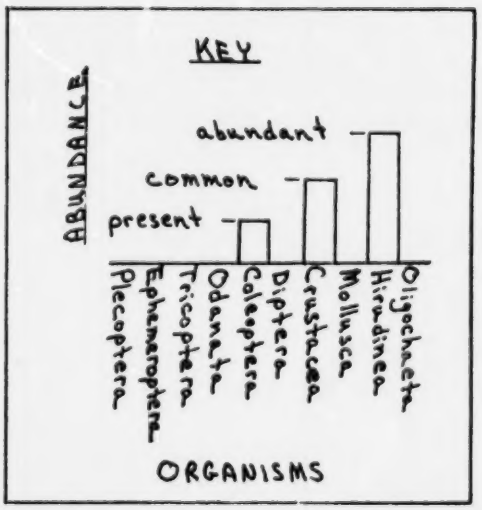
Table Br-1
(Continued)

| PARAMETER | Date 1974 | Hwy S | Hwy B | Hwy 2 | Hwy FF | Hwy 13 | Mouth IX | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $NH_3$-N | 4/18 | .13 | .13 | .05 | .05 | .10 | .10 | | | | | | | | |
| | 6/20 | .04 | .04 | .05 | .04 | .11 | .03 | .02 | .07 | .07 | .07 | .02 | .07 | .06 | .04 |
| | 9/16 | .11 | .06 | .13 | .13 | .19 | .05 | .08 | .04 | .07 | .18 | .14 | .13 | .17 | .13 |
| Sol. Phos. | 4/18 | .27 | .014 | .012 | .014 | .016 | .018 | | | | | | | | |
| | 6/20 | .018 | .014 | .010 | .006 | .010 | .012 | .010 | .010 | .010 | .010 | .012 | .012 | .010 | .010 |
| | 9/16 | .024 | .014 | .008 | .011 | .014 | .014 | .014 | .005 | .009 | .01 | .012 | .012 | .005 | .008 |
| Total Phos. | 4/18 | .38 | .07 | .05 | .08 | .10 | .12 | | | | | | | | |
| | 6/20 | .06 | .03 | .04 | .04 | .05 | .06 | .04 | .04 | .04 | .04 | .04 | .03 | .03 | .03 |
| | 9/16 | .03 | .03 | .02 | .02 | .03 | .05 | .04 | .03 | .05 | .05 | .04 | .03 | .02 | .03 |
| Alkalinity Total ($CaCO_3$) | 4/18 | 24 | 40 | 32 | 26 | 28 | 25 | | | | | | | | |
| | 6/20 | 44 | 52 | 52 | 50 | 50 | 50 | 48 | 44 | 42 | 44 | 48 | 44 | 42 | 50 |
| | 9/16 | 46 | 52 | 52 | 52 | 56 | 46 | 58 | 40 | 44 | 42 | 42 | 58 | 40 | 44 |
| Silica | 6/20 | 12.8 | 11.4 | 11 | 10.4 | 11.2 | 10.4 | 7.4 | 3.8 | 3.7 | 3.8 | 6.6 | 5.2 | 3.7 | 3.6 |
| | 9/16 | 13.4 | 11.2 | 2.7 | 11.2 | 11.8 | 2.5 | 11.4 | 2.0 | 2.4 | 2.4 | 2.4 | 11.6 | 2.4 | 2.4 |
| Chlorides | 6/20 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 36 | 0 | 0 | 1 | 0 |
| | 9/16 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| Hardness | 4/18 | 29 | 41 | 37 | 30 | 32 | 32 | | | | | | | | |
| | 6/20 | 46 | 2 | 52 | 48 | 51 | 52 | 50 | 48 | 48 | 48 | 50 | 49 | 47 | 47 |
| | 9/16 | 50 | 54 | 48 | 60 | 68 | 52 | 60 | 48 | 52 | 52 | 48 | 68 | 46 | 48 |
| Temp. ($^oC$) | 4/18 | 6 | 9 | 2 | 4 | 4 | 4 | | | | | | | | |
| | 6/20 | 14 | 15 | 15 | 17 | 17 | 17 | 16 | 14 | 14 | 15 | 16 | 15 | 15 | 15 |
| | 9/16 | 10 | 11 | 11.5 | 12 | 12 | 13 | 13 | 12 | 12 | 12 | 12 | 12 | 12 | 11 |
| D.O. | 4/18 | 9.2 | 10.7 | 11.8 | 12.5 | 113.7 | 12.7 | | | | | | | | |
| | 6/20 | 8.8 | 8.8 | 9.1 | 9.4 | 8.8 | 9.1 | 9.5 | 10.3 | 10.4 | 10.4 | 10.6 | 10.0 | 10.2 | 10.4 |
| | 9/16 | 9.4 | 10.5 | 10.6 | 11.6 | 11.6 | 11.6 | 11.2 | 11.2 | 11.0 | 11.0 | 11.2 | 11.0 | 11.2 | 11.2 |
| pH (S.U.) | 4/18 | 6.8 | 7.1 | 7.1 | 7.0 | 7.0 | 7.0 | | | | | | | | |
| | 6/20 | 7.2 | 7.5 | 7.4 | 7.4 | 7.6 | 7.6 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 |
| | 9/18 | 7.2 | 7.4 | 7.4 | 7.6 | 7.6 | 7.5 | 7.4 | 7.4 | 7.5 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 |
| Turbidity (N.T.U.) | 6/20 | .78 | 1.3 | 2.2 | 2.8 | 6.0 | 1.2 | 7.8 | 8.8 | 8.8 | 12 | 12 | 12 | 6.8 | 6.6 |
| | 9/16 | .97 | .48 | 4.3 | 1.1 | 2.3 | 52 | 4.0 | 9.0 | 32 | 15 | 22 | 2.0 | 6.2 | 20 |
| Secchi Disk | 6/20 | | | | | | 1.7 | 1.7 | 2.1 | 2.0 | 2.2 | 2.1 | 1.7 | 2.8 | 3.0 |
| | 9/16 | | | | | | 3.4 | 1.0 | 2.8 | 1.0 | 1.8 | 1.75 | 1.4 | 4.0 | 4.5 |

All values in mg/l except where specified (1)Refer to Figure Br-1 (2)Refer to Figure Br-2

djt
6/10/76



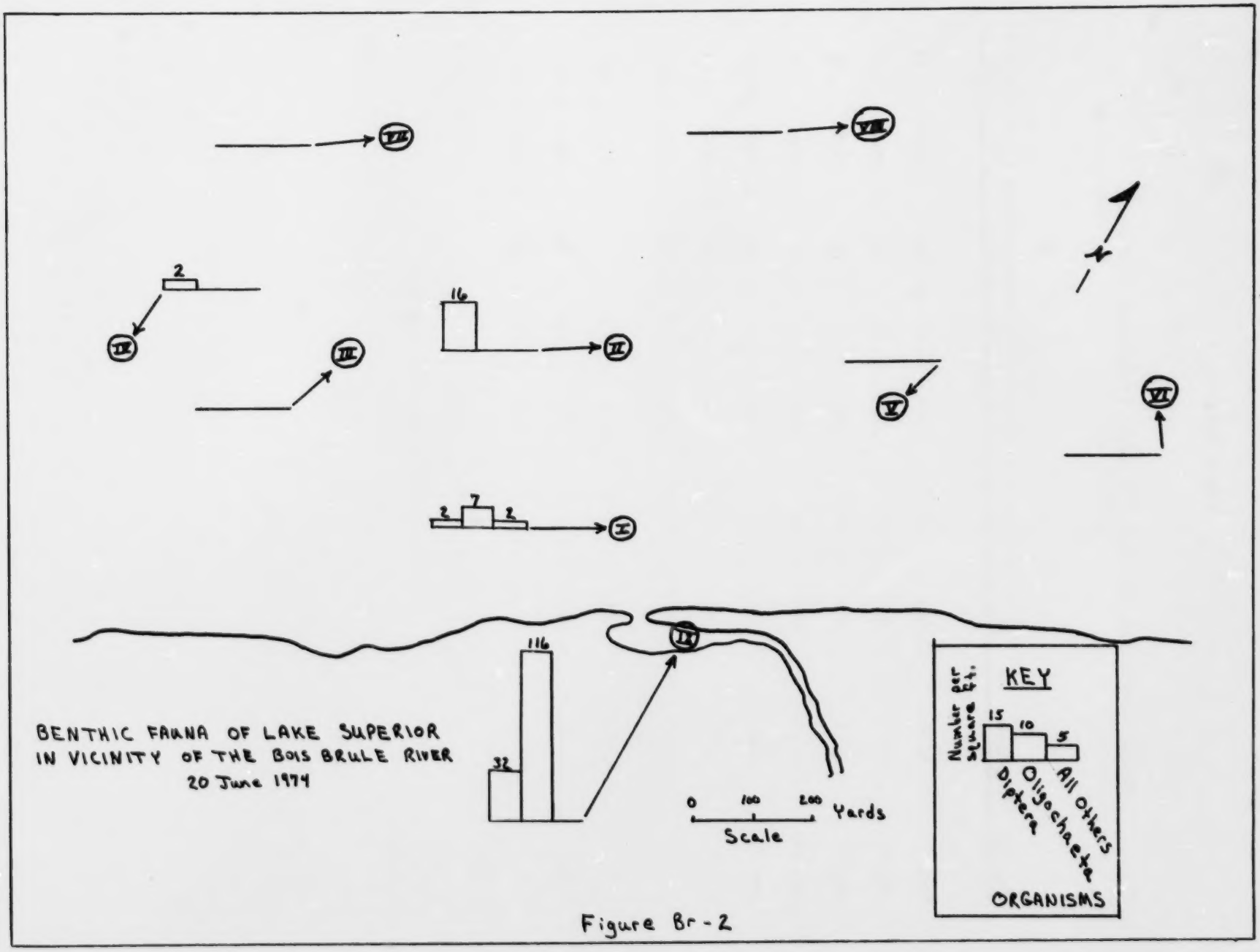




0 1 2 Miles
Scale

BENTHIC FAUNA OF THE BRULE RIVER

20 June 1974

Figure Br-1




BENTHIC FAUNA OF LAKE SUPERIOR
IN VICINITY OF THE BOIS BRULE RIVER
20 June 1974

Figure Br-2

TABLE Br- 2

METALS CONCENTRATIONS FROM THE BRULE RIVER-LAKE SUPERIOR DURING 1974

| Station (1) | Date | Metals | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Cd | Cr | Cu | Ni | Pb | Hg | Zn |
| Hwy S | 4/18 | <.002 | .01 | .005 | <.01 | <.02 | .0004 | .009 |
| Hwy B | 4/18 | <.002 | .014 | .004 | <.01 | .03 | <.0002 | .010 |
| Hwy 2 | 4/18 | <.002 | <.01 | .002 | <.01 | <.02 | <.0002 | .010 |
| Hwy FF | 4/18 | <.002 | <.01 | .004 | <.01 | <.02 | <.0002 | .071 |
| Hwy 13 | 4/18 | <.002 | .01 | .006 | <.01 | <.02 | <.0002 | .011 |
| Mouth | 4/18 | <.002 | <.01 | .011 | <.01 | <.02 | .0002 | .065 |
| | 6/20 | <.0002 | <.0008 | <.001 | <.006 | <.005 | <.0003 | <.05 |
| I | 6/20 | <.0002 | <.0008 | <.001 | <.006 | <.005 | <.0003 | <.05 |
| III | 6/20 | <.0002 | <.0008 | .005 | <.006 | <.005 | .0003 | <.05 |
| V | 6/20 | <.0002 | <.0008 | <.001 | <.006 | <.005 | <.0003 | <.05 |

All values in mg/l

(1) Refer to Figures Br-2 and Br-3

TABLE Br-3

AVERAGE CONCENTRATIONS FOR SELECTED PARAMETERS AT STATIONS
NEAR THE MOUTH OF THE BRULE RIVER
(Refer to Table Br-1)

| Parameter | River Mouth IX | Stations Closest to River Mouth (I, II, III, V) | Stations Furthest from River Mouth (IV, VI, VII, VIII) |
|---|---|---|---|
| Total Solids | 106 | 88 | 79 |
| Total Org. N. | .28 | .24 | .23 |
| Total Phos. | .055 | .038 | .031 |
| Silica | 6.45 | 4.96 | 4.38 |
| Hardness | 52 | 50 | 50 |
| Turbidity (T.U.) | 32 | 13.0 | 38.7 |
| Secchi Disk (Ft.) | 2.6 | 1.8 | 2.7 |

Bad River

The chemical characteristics of the Bad River system as documented during this project are shown in Table Ba-1. In common with the Nemadji and Brule Rivers, the Bad River watershed contains a significant amount of red clay. This is reflected in the high solids concentrations, particularly during the spring runoff period. In comparison, the Bad River carries more silt load than the Bois Brule but still much less than the Nemadji.

The results from this survey seem to indicate the solids load is reduced between Highway 2 and the river mouth (Station IX). This may be the result of the physical characteristics of the lower river (the river below Highway 2 is almost at lake elevation and becomes wide and slow-moving) enabling the heavier clay particles to settle out. However, assumptions about data from Station IX are difficult because this site could almost be considered a fresh water estuary environment and the water circulation in this area may at times be influenced by wind seiches or other movements of the lake.

Table Ba-3 shows a comparison of water quality data from the river mouth (Station IX) with those stations closest to the mouth (II, III, IV and VII) and those furthest away (I, V, VI and VIII). This data seems to indicate a definite influence on lake water quality from the Bad River within the relatively small area covered by this survey. All of the parameters checked showed decreases in concentrations with distance from the river mouth. The biological survey results indicate that the Bad River and its major tributaries support a rich benthic fauna with intolerant organisms well represented at all stations. The widely diverse populations and relative abundance are indicative of normal clean water environments.

In comparison with the Brule River area, the Lake Superior stations off the Bad River are much more productive. This situation appeared mainly to be the result of physical habitat conditions. The sand bottom was not as hard packed and at several of the stations, was mixed with substantial amounts of clay. In addition, Stations I, VII and IV showed significant amounts of organic debris as a thin bottom covering.

The concentrations of metals found in the Bad River System and Lake Superior during this survey are shown in Table Ba-2. Most of the concentrations are quite low and are below Water Quality Criteria recommendations.

The glaring exception to the above are the high levels of lead found at several locations during the April 22nd sampling. These levels are not related to any known pollutional "point source" and it is suspected that some sampling or analytical error is involved. Resampling of those stations which showed high lead levels will be undertaken in the near future.

One totally unexplainable result is the .6 ug/l concentration of mercury found at Lake Superior Station IV on June 26. This concentration does not appear related to any Bad River influence and is certainly out of line with expected lake water quality. Further sampling of Lake Superior stations will be done in 1975 if our work load permits.

TABLE Ba-1

RESULTS OF GENERAL CHEMISTRY ANALYSIS
Bad River-Lake Superior

| Parameter | Date 1974 | River Stations(1) Hwy 169 | White R. Hwy 13 | Marengo River Near Highbridge | Hwy 2 | Mouth IX | Lake Stations(2) I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MFCC | 4-22 | 700 | 700 | 800 | 1200 | (3) | | | | | | | | |
| (No./100 ml) | 6-26 | | 300 | | | 300 | <100 | <100 | 100 | <100 | <100 | <100 | <100 | <100 |
| | 9-18 | 13000 | 510 | 1,400 | 300 | 170 | 230 | 340 | 60 | 140 | 140 | 200 | | 210 |
| MFFCC | 4-22 | <10 | 30 | 20 | 70 | | | | | | | | | |
| (No./100 ml) | 6-26 | 30 | <10 | 60 | 10 | 20 | 10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| | 9-18 | 720 | 20 | 150 | 40 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | | <10 |
| BOD | 4-22 | 2.5 | 2.0 | 2.5 | 2.5 | | | | | | | | | |
| (5 day) | 6-26 | 2.5 | 1.2 | 2.5 | 2.5 | 2.9 | 2 | 2 | 2.5 | 2 | 2 | 1.6 | 1.6 | 2 |
| | 9-18 | .8 | 1.2 | 1.2 | 2.0 | 1.2 | .8 | .8 | .8 | .8 | 1.2 | 1.2 | | 1.6 |
| Total | 4-22 | 88 | 162 | 216 | 342 | | | | | | | | | |
| Solids | 6-26 | 76 | 120 | 124 | 102 | 98 | 58 | 54 | 106 | 62 | 46 | 56 | 52 | 50 |
| | 9-18 | 44 | 276 | 104 | 138 | 84 | 60 | 64 | 64 | 52 | 54 | 54 | | 48 |
| Susp. | 4-22 | 25 | 55 | 126 | 266 | | | | | | | | | |
| Solids | 6-26 | 1 | 13 | 12 | 4 | 5 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 |
| | 9-18 | 3 | 134 | 8 | 25 | 15 | 8 | 12 | 12 | 6 | 5 | 5 | | 3 |
| Total | 4-22 | | 5 | 6 | 13 | | | | | | | | | |
| Susp. | 6-26 | 1 | 1 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Solids | 9-18 | 0 | 10 | 0 | 0 | 1 | 1 | 2 | 0 | 1 | 1 | 1 | | 0 |
| Total | 4-22 | .62 | .62 | .60 | .78 | | | | | | | | | |
| Org. N | 6-26 | .60 | .27 | .38 | .48 | .43 | .19 | .14 | .40 | .13 | .16 | .14 | .16 | .19 |
| | 9-18 | .58 | .37 | .33 | .40 | .25 | .09 | .10 | .12 | .05 | .15 | .09 | | .09 |
| Nitrate - N | 4-22 | .11 | .08 | .15 | .12 | | | | | | | | | |
| | 6-26 | .04 | .03 | .09 | <.01 | <.01 | .16 | .16 | .01 | .18 | .18 | .16 | .15 | .16 |
| | 9-18(4) | .02 | .03 | .07 | .05 | .18 | .25 | .24 | .24 | .25 | .25 | .25 | | .25 |
| Nitrite - N | 4-22 | .003 | .007 | .006 | .008 | | | | | | | | | |
| | 6-26 | .005 | .004 | .004 | .005 | .005 | .003 | .003 | .005 | .003 | .003 | .003 | .004 | .003 |
| | 9-18(4) | | | | .006 | | | | | | | | | |

Table Ba-1
Continued

| Parameter | Date 1974 | Hwy 169 | White R. Hwy 13 | Marengo River Near Highbridge | Hwy 2 | Mouth IX | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $NH_3$-N | 4-22 | .13 | .14 | .14 | | | | | | | | | | |
| | 6-26 | .10 | .04 | .02 | .04 | .03 | .09 | .01 | .02 | .02 | .01 | .04 | .08 | .05 |
| | 9-18 | .08 | .10 | .04 | .11 | .03 | .05 | .07 | .03 | .09 | .04 | .06 | | .07 |
| Sol. Phos. | 4-22 | .010 | .026 | .020 | .024 | | | | | | | | | |
| | 6-26 | .012 | .012 | .012 | .010 | .004 | .003 | .004 | .012 | <.002 | <.002 | .004 | .004 | <.002 |
| | 9-18 | .016 | .034 | .013 | .015 | .008 | .004 | .004 | .004 | .006 | .004 | .005 | | .004 |
| Total Phos. | 4-22 | .07 | .12 | .26 | .21 | | | | | | | | | |
| | 6-26 | .04 | .03 | .04 | .03 | .04 | .02 | .01 | .04 | .01 | .01 | .02 | .01 | .01 |
| | 9-18 | .03 | .105 | .10 | .04 | .03 | .02 | .02 | .02 | .02 | .015 | .02 | | .015 |
| Alkalinity Total ($CaCO_3$) | 4-22 | 8 | 40 | 20 | | | | | | | | | | |
| | 6-26 | 30 | 86 | 54 | 70 | 62 | 44 | 42 | 60 | 42 | 44 | 44 | 42 | 42 |
| | 9-18 | 26 | 98 | 66 | 52 | 42 | 42 | 42 | 41 | 40 | 42 | 42 | | 42 |
| Silica | 6-26 | 7.6 | 11.0 | 9.2 | 8.9 | 8.4 | 2.9 | 2.6 | 8.7 | 2.3 | 2.5 | 2.4 | 2.4 | 2.5 |
| | 9-18 | 10.0 | 11.9 | 9.6 | 10.6 | 6.0 | 2.6 | 2.8 | 2.2 | 2.3 | 2.2 | 2.2 | | 2.2 |
| Chlorides | 6-26 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| | 9-18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 |
| Hardness | 4-22 | 18 | 47 | 29 | 28 | | | | | | | | | |
| | 6-26 | 36 | 88 | 56 | 68 | 64 | 48 | 52 | 64 | 44 | 66 | 44 | 44 | 44 |
| | 9-18 | 38 | 94 | 55 | 56 | 53 | 52 | 56 | 46 | 46 | 46 | 44 | | 46 |
| Temp. °C | 4-22 | 5 | 7 | 6 | 6 | | | | | | | | | |
| | 6-26 | 19 | 19.5 | 19.5 | 22 | 21 | 16 | 18 | 21 | 17 | 17 | 16 | 18 | 17 |
| | 9-18 | 14 | 15 | 16 | 13 | 14 | 14 | 14 | 14 | 14 | 13.5 | 14 | | 14 |
| D.O. | 4-22 | 11.9 | 11.8 | 11.6 | 11.0 | | | | | | | | | |
| | 6-26 | 9.6 | 9.3 | 9.6 | 8.1 | 8.4 | 11 | 11 | 8.6 | 11.2 | 11 | 11 | 11 | 11 |
| | 9-18 | 10.6 | 11.6 | 11.3 | 10.4 | 10.6 | 10.5 | 10.4 | 10.4 | 10.6 | 10.6 | 10.5 | | 10.6 |

Table Ba-1
Continued

| Parameter | Date 1974 | Hwy 169 | White R. Hwy 13 | Marengo River Near Highbridge | Hwy 2 | Mouth IX | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH (Su) | 4-22 | 7.0 | 7.2 | 7.0 | 7.0 | | | | | | | | | |
| | 6-26 | 7.0 | 8.0 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.3 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 |
| | 9-18 | 7.2 | 7.6 | 7.6 | 7.4 | 7.4 | 7.4 | 7.4 | 7.5 | 7.4 | 7.4 | 7.4 | | 7.4 |
| Turbidity | 6-26 | .77 | 6.3 | 3.1 | 4.7 | 3.4 | .90 | .90 | 5.0 | .85 | .75 | .68 | .73 | .85 |
| (T.U.) | 9-18 | .95 | 57 | 1.5 | 18 | 8.3 | 3.5 | 6.5 | 7.3 | 3.4 | 2.2 | 2.8 | | 1.3 |
| Secchi Disk | 6-26 | | | | | 2.8 | 10.7 | 9.0 | 4.7 | 14.5 | 2.2 | 11.5 | 13.5 | 12.5 |
| (feet) | 9-18 | | | | | 2.0 | 3.0 | 2.2 | 2.0 | 2.2 | 14.0 | 4.8 | | 7.5 |

All values in mg/l unless specified

(1) Refer to Figure Ba-2

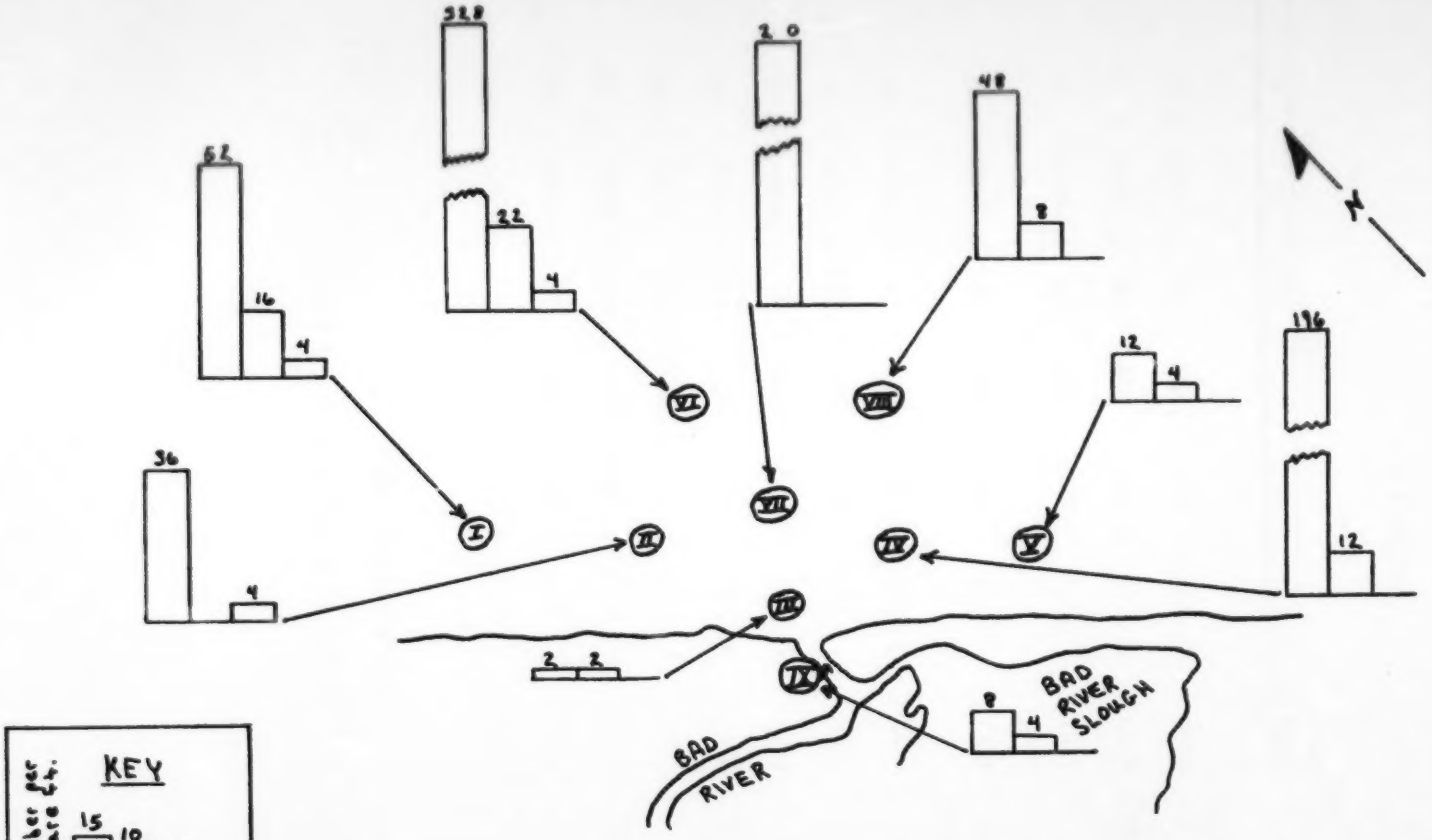
(2) Refer to Figure Ba-3

(3) Blank spaces indicate data not collected on that date

(4) Data for 9/18 includes Nitrate-N and nitrite-N combined

BENTHIC FAUNA OF THE BAD RIVER WATERSHED
26 June 1974

Figure Ba -1




BENTHIC FAUNA OF LAKE SUPERIOR IN VICINITY
OF THE BAD RIVER
26 June 1974

0 1/4 1/2 Miles
Scale

Figure Ba-2

TABLE Ba- 2

METALS CONCENTRATIONS FROM THE BAD RIVER WATERSHED-LAKE SUPERIOR

DURING 1974

| Station[1] | Date 1974 | Metals | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Cd | Cr | Cu | Pb | Hg | Ni | Zn |
| Bad River, Hwy 13 | 4/22 | <.002 | .01 | .005 | .27 | <.0002 | <.01 | .023 |
| Bad River, Hwy. 169 | 4/22 | <.002 | <.01 | .004 | .06 | <.0002 | <.01 | .014 |
| Marengo River- near Highbridge | 4/22 | .002 | .015 | .012 | .14 | <.0002 | .01 | .064 |
| Potato River, above confluence w/ Bad R. | 4/22 | .002 | .01 | .008 | .14 | <.0002 | .01 | .026 |
| White R., Hwy 13 | 4/22 | <.002 | <.01 | .007 | <.02 | <.0002 | .01 | .025 |
| Bad River, Hwy 2 | 2/21 | .0001 | .0023 | .0034 | <.002 | <.0002 | <.01 | <.02 |
| | 4/19 | <.002 | .015 | .010 | <.02 | <.0002 | <.01 | .075 |
| | 4/22 | <.002 | .010 | .012 | .15 | <.0002 | .01 | .033 |
| | 7/29 | <.0003 | .002 | <.002 | <.003 | .0002 | <.005 | <.02 |
| Bad River Mouth(IX) | 6/26 | <.0002 | <.0008 | <.001 | <.005 | <.0003 | <.006 | <.05 |
| Station II | 6/26 | <.0002 | <.0008 | .004 | <.005 | .0006 | <.006 | <.05 |
| Station IV | 6/26 | <.0002 | <.0008 | .003 | <.005 | <.0003 | .015 | <.05 |

All values in mg/l

[1] Refer to Figures Ba-2 and Ba-3

TABLE Ba-3

AVERAGE CONCENTRATIONS FOR SELECTED PARAMETERS AT STATIONS NEAR THE MOUTH OF THE BAD RIVER

| Parameter | River Mouth | Stations Closest to Mouth (II,III,IV, & VII) | Stations Furthest from Mouth (I, V, VI, & VIII) |
|---|---|---|---|
| Total Solids | 91 | 65 | 53 |
| Total Org. N. | .34 | .16 | .14 |
| Total Phos. | .035 | .018 | .016 |
| Silica | 7.2 | 3.33 | 2.44 |
| Hardness | 58 | 50 | 49 |
| Turbidity (N.T.U.) | 5.8 | 3.5 | 1.6 |
| Secchi Disk (Ft.) | 2.4 | 6.9 | 8.3 |

Montreal River

General chemical characteristics of the Montreal River and the localized Lake Superior area are shown in Table M-1.

One problem area that becomes immediately apparent is the bacteriological contamination that occurs in and downstream from the Hurley locality. This problem is partly caused by the municipal sewage treatment plant effluents from Hurley and Ironwood, Michigan. However, additional investigative work will be implemented to document any other pollutional sources in this area. It is anticipated that the issuance of WPDES permits to Hurley and the surrounding Wisconsin communities will call for immediate steps to eliminate bacterial contamination of wastewater effluents. It is hoped that this action, along with similar action by the State of Michigan will bring a speedy solution to this problem.

The Montreal River, in contrast to the other major Wisconsin tributaries does not have a significant amount of red clay in the watershed. This fact is demonstrated in the total solids concentrations, which do not reflect the high spring loadings exhibited by the other streams.

A comparison of several chemical parameters for the river mouth and lake stations is shown in Table M-3. This data seems to indicate a localized influence on lake water quality within the relatively small area covered by this survey.

The biological investigation of the Montreal River (Figure M-1) revealed diverse benthic populations at the two stations above the Hurley sewage treatment plant. Intolerant organisms were well represented in these stable benthic communities.

The Highway 2 station, downstream from the Hurley STP exhibited a definite decrease in the presence and numbers of macroinvertebrates considered intolerant of low dissolved oxygen conditions. Although the physical habitat conditions at this site were not ideal for benthic development, it is felt that these findings are directly related to the impact on the stream from the Hurley STP.

A normal, diversified benthic population was again found at the Stateline Road station, approximately two miles downstream from the Hurley-Ironwood area. The biological community is again well represented with intolerant organisms and indicates recovery to well oxygenated conditions. The Highway 122 station is located in a flowage environment and the biological community found during this survey is probably representative and normal for this type of habitat.

Figure M-2 is a representation of benthic organisms found during sampling efforts in Lake Superior near the mouth of the Montreal River. The presence of hard substrate again hampered the collection of dredge samples. The distribution and abundance of the benthic fauna collected did not reveal any pattern indicative of a significant biological impact from the Montreal River outflow.

The metals concentrations found in the Montreal River during this survey are shown in Table M-2. Again most of the concentrations are quite low and fall below recommended levels as stated in Water Quality Criteria, 1972.

The high lead values obtained during the April 24th sampling are at this time unexplained. We are not aware of any "point sources" which contribute lead to the Montreal River. It is suspected that some sampling or analytical error may be involved with these high values. In any case resampling of those stations showing high value is being undertaken as our work load permits.

TABLE M-1

RESULTS OF GENERAL CHEMISTRY ANALYSIS

Montreal River-Lake Superior

| PARAMETER | 1974 | River Stations[1] Hwy C | Hurley Above STP | Hwy 2 | Stateline Road | Hwy 122 | Lake Stations[2] Mouth | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MFCC (No./100 ml) | 4-24 | 100 | 2,400 | 4,000 | 31,000 | 3,200 | (3) | | | | | | | | |
| | 6/27 | | | | | | 600 | <100 | <100 | 1,600 | 200 | <100 | <100 | <100 | <100 |
| | 7/2 | 700 | 24,000 | 38,000 | 22,000 | 1,900 | | | | | | | | | |
| | 10/3 | - | - | - | - | 540 | | | | | | | | | |
| MFFCC (No./100 ml) | 4/24 | 10 | 420 | 870 | 2,900 | 360 | | | | | | | | | |
| | 6/27 | | | | | | <10 | <10 | <10 | <10 | <10 | <10 | <10 | 20 | <10 |
| | 7/2 | 50 | 760 | 520 | 540 | 10 | | | | | | | | | |
| | 10/3 | 10 | 1,200 | 2,900 | 220 | 50 | 10 | 10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| B.O.D. (5 day) | 4/24 | 1.2 | 1.6 | 1.6 | 2.0 | 1.6 | | | | | | | | | |
| | 6/27 | | | | | | 1.8 | 1.5 | 1.5 | 2.2 | 1.5 | 1.8 | 1.5 | 1.2 | 1.5 |
| | 7/2 | 1.8 | 2.9 | 2.9 | 4.1 | 2.5 | | | | | | | | | |
| | 10/3 | 2.5 | 2.1 | 2.8 | 2.1 | 2.5 | 2.51 | 2.5 | 1.8 | 2.5 | 1.5 | 1.8 | 2.1 | 1.8 | 1.5 |
| Total Solids | 4/24 | 62 | 64 | 70 | 66 | 68 | | | | | | | | | |
| | 6/27 | | | | | | 76 | 54 | 54 | 72 | 54 | 48 | 54 | 58 | 54 |
| | 7/2 | 92 | 90 | 94 | 150 | 84 | | | | | | | | | |
| | 10/3 | 76 | 84 | 96 | 110 | 72 | 68 | 58 | 56 | 64 | 48 | 52 | 54 | 52 | 52 |
| Susp. Solids | 4/24 | 10 | 6 | 11 | 10 | 18 | | | | | | | | | |
| | 6/27 | | | | | | 3 | 1 | 3 | 1 | 1 | 1 | 2 | 2 | 2 |
| | 7/2 | 4 | 3 | 4 | 11 | 4 | | | | | | | | | |
| | 10/3 | 2 | 1 | 3 | 3 | 2 | 3 | 5 | 3 | 3 | 5 | 4 | 4 | 4 | 4 |
| Vol. Susp. Solids | 4/24 | 2 | 2 | 2 | 2 | 3 | | | | | | | | | |
| | 6/27 | | | | | | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| | 7/2 | 3 | 3 | 3 | 5 | 4 | | | | | | | | | |
| | 10/3 | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 2 |
| Total Org. N | 4/24 | .60 | .60 | .63 | .60 | .58 | | | | | | | | | |
| | 6/27 | | | | | | .48 | .16 | .16 | .42 | .22 | .16 | .12 | .16 | .15 |
| | 7/2 | .62 | .62 | .90 | .77 | .53 | | | | | | | | | |
| | 10/3 | .54 | .54 | .65 | .61 | .45 | .32 | 0.0 | 0.0 | .16 | .01 | 0.0 | .05 | .04 | .05 |

Table M-1
Continued

| PARAMETER | Date 1974 | River Stations[1] Hwy C | Hurley Above STP | Stateline Hwy 2 | Road | Hwy 122 | Lake Stations[2] Mouth | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nitrate - N | 4/24 | .09 | .11 | .11 | .14 | .14 | | | | | | | | | |
| | 6/27 | | | | | | .20 | .20 | .15 | .20 | .20 | .20 | .25 | .25 | .20 |
| | 7/2 | .08 | .08 | .13 | 1.05 | .14 | | | | | | | | | |
| | 10/3 | .01 | .03 | .06 | .59 | .16 | | | | | | | | | |
| | | | | | | | .17 | .24 | .24 | .21 | .24 | .24 | .24 | .24 | .24 |
| Nitrite - N | 4/24 | .005 | .005 | .005 | .006 | .005 | | | | | | | | | |
| | 6/27 | | | | | | .009 | .003 | .003 | .008 | .004 | .004 | .003 | .003 | .003 |
| | 7/2 | .005 | .006 | .015 | .047 | .006 | | | | | | | | | |
| | 10/3[3] | | | | | | | | | | | | | | |
| $NH_3$ - N | 4-24 | .10 | .10 | .08 | .10 | .10 | | | | | | | | | |
| | 6/27 | | | | | | .05 | .02 | .01 | .06 | .02 | .01 | .05 | .10 | .02 |
| | 7/2 | .07 | .08 | .41 | .07 | .07 | | | | | | | | | |
| | 10/3 | .06 | .10 | .30 | .12 | .07 | .09 | .16 | .13 | .12 | .12 | .13 | .11 | .08 | .09 |
| Sol. Phos. | 4/24 | .010 | .016 | .018 | .032 | .036 | | | | | | | | | |
| | 6/27 | | | | | | .060 | .002 | .002 | .036 | .004 | .002 | <.002 | .004 | <.002 |
| | 7/2 | .012 | .022 | .31 | .38 | .042 | | | | | | | | | |
| | 10/3 | .008 | .016 | .05 | .176 | .043 | .043 | .004 | .004 | .021 | .003 | .003 | .003 | .003 | .006 |
| Total Phos. | 4/24 | .04 | .04 | .06 | .07 | .08 | | | | | | | | | |
| | 6/27 | | | | | | .08 | .01 | .01 | .07 | .02 | .02 | .008 | .01 | .003 |
| | 7/2 | .04 | .06 | .44 | .49 | .09 | | | | | | | | | |
| | 10/3 | .02 | .04 | .10 | .25 | .07 | .08 | .02 | .01 | .04 | .01 | .01 | .01 | .01 | .01 |
| Alkalinity Tot. ($CaCO_3$) | 4/24 | 8 | 8 | 10 | 10 | 10 | | | | | | | | | |
| | 6/27 | | | | | | 32 | 42 | 40 | 34 | 38 | 40 | 40 | 40 | 40 |
| | 7/2 | 30 | 38 | 42 | 52 | 28 | | | | | | | | | |
| | 10/3 | 28 | 33 | 36 | 42 | 28 | 28 | 40 | 41 | 36 | 42 | 42 | 42 | 42 | 44 |
| Silica | 4/24 | 6.6 | 6.8 | 6.8 | 6.6 | 6.8 | | | | | | | | | |
| | 6/27 | | | | | | 6.0 | 1.9 | 2.2 | 5.3 | 2.6 | 2.4 | 2.0 | 2.0 | 2.0 |
| | 7/2 | 4.8 | 5.0 | 5.4 | 7.2 | 4.2 | | | | | | | | | |
| | 10.3 | 5.4 | 6.1 | 6.2 | 7.0 | 4.6 | 4.7 | 2.3 | 2.1 | 3.2 | 1.9 | 1.7 | 1.9 | 2.0 | 1.8 |
| Chlorides | 4/24 | | 0 | 0 | 0 | | | | | | | | | | |
| | 6/27 | | | | | | 3 | 1 | 1 | 2 | 1 | 1 | 0 | 1 | 1 |
| | 7/2 | | | 5 | 11 | 1 | | | | | | | | | |
| | 10/3 | 0 | 1 | 3 | 6 | 3 | 3 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| Hardness | 4/24 | 12 | 14 | 14 | 16 | 20 | | | | | | | | | |
| | 6/27 | | | | | | 40 | 48 | 44 | 36 | 44 | 46 | 40 | 40 | 52 |
| | 7/2 | 38 | 42 | 48 | 68 | 32 | | | | | | | | | |
| | 10/3 | 34 | 41 | 44 | 52 | 38 | 34 | 44 | 44 | 41 | 44 | 46 | 44 | 44 | 44 |

Table M-1
Continued

| PARAMETER | 1974 | River Stations(1) Hwy C | Hurley Above STP | Hwy 2 | Stateline Road | Hwy 122 | Mouth | Lake Stations(2) I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. °C | 4-24 | 5 | 4 | 5 | 5 | 4 | | | | | | | | | |
| | 6-27 | | | | | | 20 | 12 | 12 | 19 | 12.5 | 12 | 11 | 12 | 12 |
| | 7-2 | 22 | 23 | 24 | 23 | 25 | | | | | | | | | |
| | 10-3 | 6 | 6 | 6 | 6 | 8 | 7 | 9 | 10 | 9 | 9.5 | 10 | 9.5 | 10 | 10 |
| D.O. | 4-24 | 10.6 | 11.0 | 11.4 | 12.3 | 12.5 | | | | | | | | | |
| | 6-27 | | | | | | 8.4 | 11.8 | 11.4 | 9.1 | 11.4 | 10.8 | 11.6 | 10.8 | 10.8 |
| | 7-2 | 6.2 | 7.5 | 6.2 | 7.5 | 7.5 | | | | | | | | | |
| | 10-3 | 11.6 | 11.6 | 11.4 | 12.4 | 12.4 | 12.0 | 11.4 | 11.4 | 11.8 | 11.6 | 11.5 | 11.6 | 11.5 | 11.0 |
| pH (Su) | 4-24 | 6.8 | 6.8 | 6.8 | 6.9 | 7.0 | | | | | | | | | |
| | 6-27 | | | | | | 7.2 | 7.4 | 7.4 | 7.2 | 7.4 | 7.4 | 7.4 | 7.2 | 7.2 |
| | 7-2 | 6.8 | 6.8 | 7.1 | 7.6 | 7.7 | | | | | | | | | |
| | 10-3 | 7.2 | 7.2 | 7.0 | 7.2 | 7.0 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.0 | 7.2 | 7.2 |
| Turbidity (T.U.) | 4-24 | | | | | | | | | | | | | | |
| | 6-27 | | | | | | 1.7 | .8 | .75 | 1.2 | .65 | .57 | .60 | .60 | .60 |
| | 7-2 | | | | | | | | | | | | | | |
| | 10-3 | 1.1 | 1.2 | 1.4 | 1.2 | 1.2 | 1.4 | 2.2 | 2.2 | 1.2 | 1.5 | 1.8 | 2.2 | 2.2 | 1.4 |
| Secchi Disk (ft.) | 4-24 | | | | | | | | | | | | | | |
| | 6-27 | | | | | | | 12.3 | 12.3 | 8.7 | 9.0 | 11.0 | 12.9 | 14.0 | 13.8 |
| | 7-2 | | | | | | | | | | | | | | |
| | 10-3 | | | | | | | 6.8 | 6.8 | 4.9 | 5.1 | 5.0 | 5.0 | 5.0 | 5.0 |

All values in mg/l unless specified

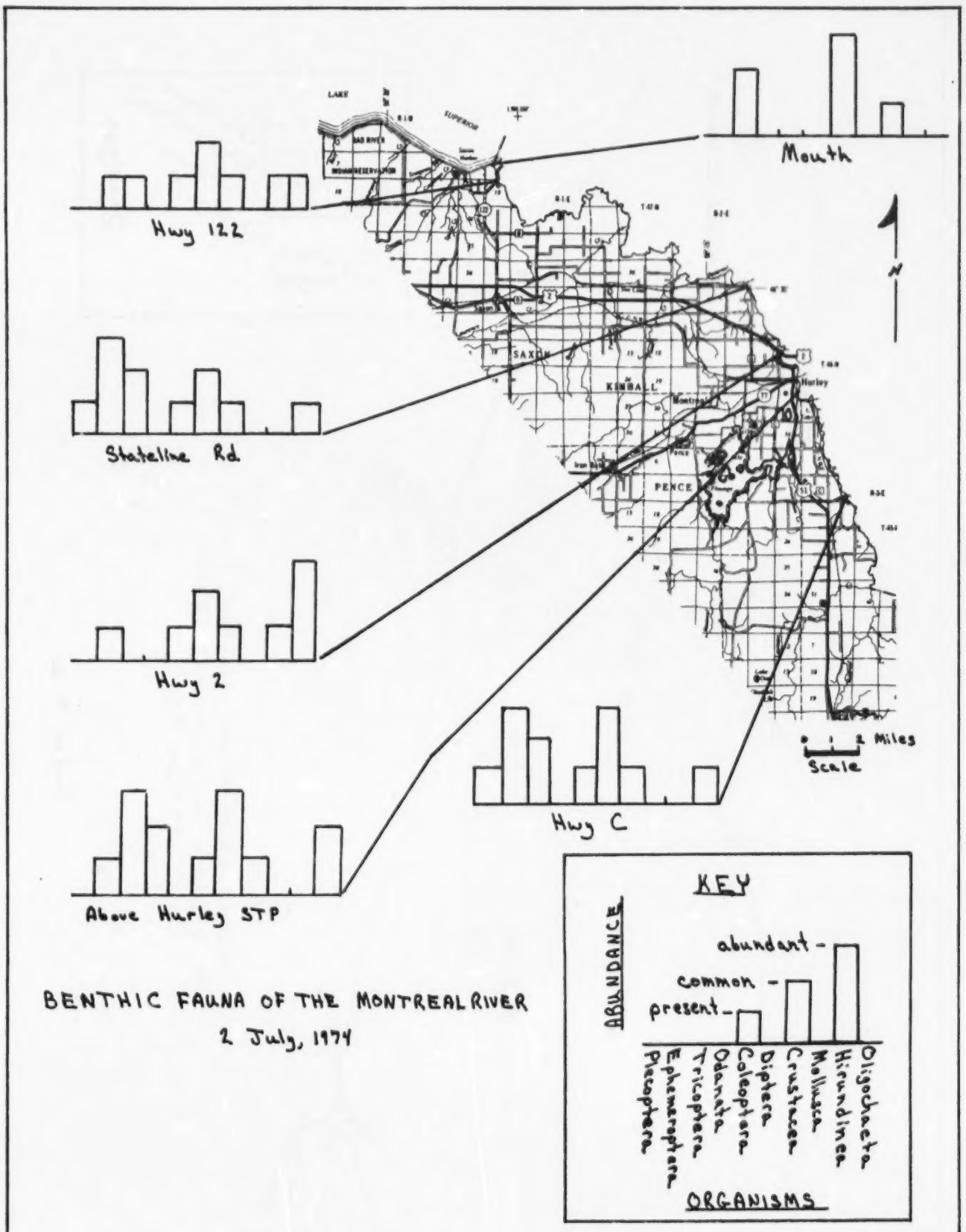
(1) Refer to Figure M-2

(2) Refer to Figure M-3

(3) Blank spaces indicate data not collected on that date

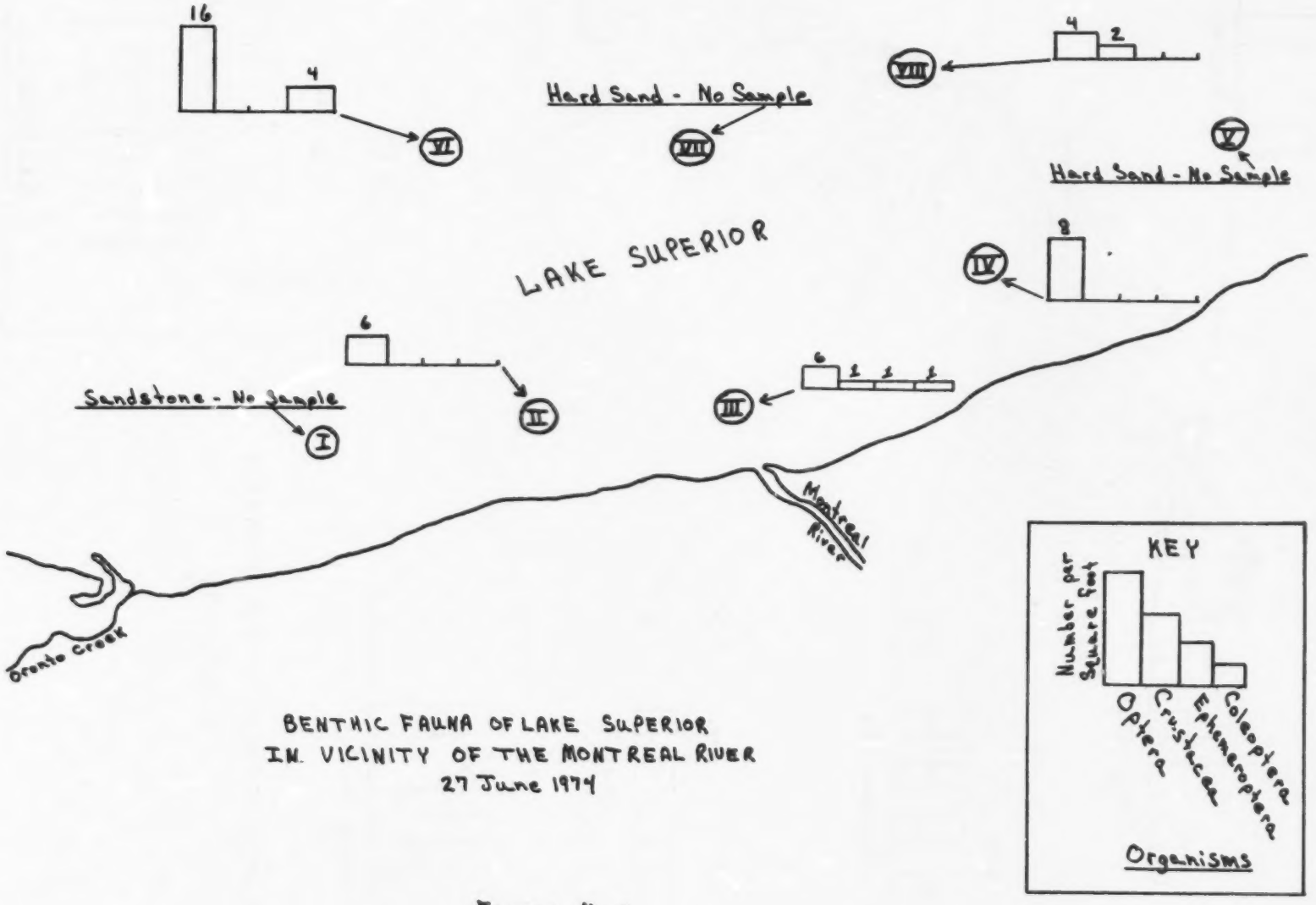
(4) Nitrate-N and nitrite-N values combined for the 10-3 data

djt
'14/76




BENTHIC FAUNA OF THE MONTREAL RIVER
2 July, 1974

Figure M-1




BENTHIC FAUNA OF LAKE SUPERIOR
IN VICINITY OF THE MONTREAL RIVER
27 June 1974

Figure M-2

TABLE M-2

METALS CONCENTRATIONS FROM THE MONTREAL RIVER-LAKE SUPERIOR DURING 1974

| Station[1] | Date | Metals | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Cd | Cr | Cu | Pb | Hg | Ni | Zn |
| Hwy G | 4/24 | .002 | .015 | .004 | .10 | <.0002 | <.01 | .010 |
| Hwy C | 4/24 | .002 | <.01 | .003 | .25 | <.0002 | <.01 | .010 |
| Hurley (above STP) | 4/24 | .002 | .010 | .007 | .15 | <.0002 | <.01 | .018 |
| Hwy 2 | 4/24 | .002 | <.01 | .005 | .18 | <.0002 | <.01 | .013 |
| Stateline Rd. | 4/24 | <.002 | <.01 | .013 | .25 | <.0002 | <.01 | .007 |
| Hwy 122 | 2/21 | .0001 | .0014 | .0013 | <.002 | <.0002 | <.01 | <.02 |
| | 4/19 | <.002 | .01 | .077 | <.02 | <.0002 | <.01 | .015 |
| | 4/24 | <.002 | <.01 | .016 | .25 | <.0002 | <.01 | .008 |
| | 7/29 | <.0003 | .002 | .002 | <.003 | .0002 | <.005 | <.02 |
| River Mouth (Sta. IX) | 6/27 | <.0002 | <.0008 | <.001 | <.005 | <.0002 | <.006 | <.05 |
| Lake Sta. II | 6/27 | <.0002 | <.0008 | <.001 | <.005 | <.0002 | <.006 | <.05 |
| Lake Sta. IV | 6/27 | <.0002 | <.0008 | <.001 | <.005 | <.0002 | <.006 | <.05 |

All values in mg/l

[1] Refer to Figures M-2 and M-3

TABLE M- 3

AVERAGE CONCENTRATIONS FOR SELECTED PARAMETERS AT STATIONS NEAR THE MOUTH OF THE MONTREAL RIVER(1)

| | Stations | | | | |
|---|---|---|---|---|---|
| Parameter | River Mouth | III | II & IV | I & V | VI, VII & VIII |
| Total Solids | 72 | 68 | 53 | 53 | 54 |
| Total Org. N. | .4 | .29 | .098 | .08 | .095 |
| Total Phos. | .08 | .055 | .012 | .015 | .0085 |
| Silica | 5.35 | 4.25 | 2.2 | 2.1 | 1.95 |
| Hardness | 37 | 39 | 44 | 46 | 44 |
| Turbidity | 1.55 | 1.2 | 1.28 | 1.34 | 1.27 |
| Secchi Disk | | 6.8 | 8.3 | 8.77 | 9.28 |

(1) Refer to Table M-1

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# APPENDIX A

## 1973 and 1974 DATA SUMMARIES

Nemadji River
Bois Brule River
Bad River
Montreal River

## SURFACE WATER QUALITY RECORD

Source: Nemadji River at Highway C Year: 1974

| Date | 1/28 | 2/14 | 3/14 | 4/10 | 4/18 | 4/21 | 4/23 | 4/25 | 6/4 | 6/18 | 7/22 | 9/3 | 9/11 | 10/4 | 11/13 | 12/12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field Data** | | | | | | | | | | | | | | | | |
| Temp. °C | 1 | 0 | 0 | 1 | 3 | 5 | 4 | 7 | 18 | 13 | 20 | 13.5 | 14.9 | 9 | 2 | 1 |
| D.O. (mg/1) | 11.3 | 11.7 | 12.5 | 13.0 | 12.6 | 11.4 | 12.3 | 12.6 | 8.3 | 9.4 | 8.4 | 9.8 | 9.4 | 11.0 | 12.7 | 12.7 |
| pH (su) | 7.4 | 7.4 | 7.6 | 7.6 | 7.5 | 7.2 | 7.0 | 7.0 | 7.4 | 7.4 | 7.8 | 7.8 | 7.8 | 7.8 | 7.3 | 7.4 |
| **Bacteriological** | | | | | | | | | | | | | | | | |
| MFFCC/100 ml | 10 | - | 30 | 200 | 30 | 20 | 20 | 10 | 50 | 20 | | 20 | 30 | 10 | 20 | 10 |
| MFCC/100 ml | - | - | 1400 | 2400 | 3700 | 1300 | 100 | 400 | 200 | 600 | | 1400 | 100 | 290 | | 120 |
| **Lab Analysis Data** | | | | | | | | | | | | | | | | |
| BOD, 5-day | 2.5 | 1.2 | 2.1 | 3.7 | 3.3 | 0.8 | 2.5 | 2.5 | 3.4 | 2.0 | 2.5 | 2.5 | 2.9 | .9 | 1.8 | |
| Total Solids | 188 | 186 | 180 | 1352 | 1350 | 418 | 460 | 320 | 168 | 210 | 362 | 188 | 180 | 190 | 153 | |
| Suspended Solids | 12 | 8 | 11 | 312 | 1155 | 292 | 326 | 22 | 36 | 85 | 202 | 9 | 14 | 10 | 21 | |
| Volatile Suspended Solids | - | 1 | 2 | 21 | 50 | 20 | 21 | 8 | 4 | 9 | 14 | 1 | 3 | 9 | 3 | |
| Total Organic Nitrogen | .28 | .44 | .65 | 1.25 | .91 | .73 | 1.08 | .77 | .62 | .62 | .62 | .42 | .37 | .50 | .52 | |
| Nitrate Nitrogen | .24 | .18 | .31 | .24 | .10 | .18 | .10 | .11 | .30 | .01 | .11 | .03 | .06 | .03 | .07 | |
| Ammonia Nitrogen | .10 | .04 | .14 | .10 | .13 | .11 | .16 | .07 | .07 | .03 | .01 | .04 | .01 | .0 | .03 | |
| Nitrite Nitrogen | .007 | .007 | .013 | .012 | .013 | .009 | .007 | .012 | .011 | .006 | .005 | .002 | .001 | .002 | | |
| Total Phosphorus | .04 | .03 | .07 | .86 | .86 | .24 | .24 | .18 | .08 | .10 | .14 | .03 | .04 | .05 | .05 | |
| Soluble Phosphorus | - | .012 | - | .030 | .028 | .006 | .022 | .036 | .034 | .012 | .019 | .012 | .008 | .006 | .010 | |
| Silica | - | 13 | 13.8 | | | 10.2 | | 10 | 7.8 | 7.2 | 14 | 10 | 11.2 | 13.2 | 11 | |
| Total Iron | | .92 | 1.16 | 37 | | 9.4 | | | 1.14 | 3.4 | 8.5 | 1.04 | .96 | .60 | 1.76 | |
| Phenol | | .005 | .005 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | |
| Manganese | | | .04 | .04 | | .08 | | | .05 | .08 | .11 | .07 | .11 | .04 | .04 | |
| Chlorides | 2 | 3 | 5 | 0 | | 0 | | 0 | 0 | 1 | 3 | 1 | 2.0 | 3 | 2 | |
| Alkalinity Total ($CaCO_3$) | 110 | 100 | 90 | 50 | 44 | 41 | 40 | 40 | 64 | 60 | 96 | 106 | 112 | 120 | 63 | |
| Hardness | 122 | 124 | 100 | 62 | 76 | 52 | 56 | 56 | 72 | 74 | 104 | 118 | 124 | 130 | 76 | |
| Conductivity micro/cm | | 235 | 206 | 163 | | 116 | | | 135 | | 240 | 243 | 265 | 264 | 153 | |
| Color | 35 | 102 | 80 | 350 | | 120 | | | 100 | 140 | 60 | 30 | 15 | 30 | 120 | |
| Turbidity | | | | 32 | | 90 | | | 29 | 41 | 140 | 16 | 16 | 5.1 | 25 | |
| pH (su) | 7.5 | 7.7 | 7.8 | 7.9 | 7.4 | 7.4 | 7.2 | 7.2 | 7.6 | 7.3 | 7.8 | 8.1 | 7.8 | 7.8 | 7.6 | |

| Date | 1/28 | 2/14 | 3/14 | 4/10 | 4/18 | 4/21 | 4/23 | 4/25 | 6/4 | 6/18 | 7/22 | 9/3 | 9/11 | 10/4 | 11/13 | 12/12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COD | | 34 | | | | 39 | | | | | 31 | | | | | |
| Cyanide | | .02 | | | | .01 | | | | | .02 | | | | | |
| Fluoride | | .15 | | | | .15 | | | | | .10 | | | | | |
| Magnesium | | | | | | .08 | | | | | | | | | | |
| Potassium | | | | | | 1.7 | | | | | 3.2 | | | | | |
| Sodium | | | | | | 1.8 | | | | | 4.8 | | | | | |
| Sulphate | | 14 | | | | 2 | | | | | 12 | | | | | |
| Calcium | | | | | | 16 | | | | | 29 | | | | | |
| **Metals (mg/l)** | | | | | | | | | | | | | | | | |
| Arsenic | | .02 | | | | | | | | | .002 | | | | | |
| Barium | | .05 | | | | | | | | | .070 | | | | | |
| Cadmium | | .0002 | | | | | | | | | .004 | | | | | |
| Chromium | | .0012 | | | | | | | | | .01 | | | | | |
| Copper | | .0006 | | | | | | | | | .015 | | | | | |
| Lead | | .002 | | | | | | | | | .05 | | | | | |
| Mercury | | .0002 | | | | | | | | | .0002 | | | | | |
| Nickel | | .01 | | | | | | | | | .01 | | | | | |
| Selenium | | .002 | | | | | | | | | .01 | | | | | |
| Zinc | | .02 | | | | | | | | | .04 | | | | | |
| **Organics (ppb)** | | | | | | | | | | | | | | | | |
| DDT | | .004 | | | | .04 | | | | | .01 | | | | | |
| DDD | | .004 | | | | .02 | | | | | .005 | | | | | |
| DDE | | .002 | | | | .02 | | | | | .01 | | | | | |
| PCB | | .04 | | | | .3 | | | | | .04 | | | | | |
| Aldrin | | .005 | | | | .01 | | | | | .002 | | | | | |
| Dieldrin | | .002 | | | | .01 | | | | | .005 | | | | | |
| Heptachlor | | .002 | | | | .01 | | | | | .002 | | | | | |
| Heptachlor Epoxide | | .002 | | | | .01 | | | | | .002 | | | | | |
| Lindane | | .001 | | | | .005 | | | | | .002 | | | | | |
| Methoxychlor | | .01 | | | | .02 | | | | | .01 | | | | | |
| Phthalate | | .2 | | | | .2 | | | | | .5 | | | | | |
| **Radiological** | | | | | | | | | | | | | | | | |
| Gross Alpha | | 1.1 | | | | | | | | | 2.6 | | | | | |
| Gross Beta | | 3.9 | | | | 11.7 | | | | | 12.2 ± 1.6 | | | | | |
| $H^3$ | | 367 | | | | 380 | | | | | | | | | | |
| $Sr^{90}$ | | 1.7 | | | | 5.2 ± 1.0 | | | | | | | | | | |
| $Ra^{226}$ | | 0.9 | | | | 2.5 | | | | | | | | | | |

(Results in mg/l unless specified)

SURFACE WATER QUALITY RECORD

Source: Brule River at Highway 13 Year: 1973

| Date- | 6/27 | 7/31 | 9/5 | 9/25 | 10/25 | 11/20 | 12/17 |
|---|---|---|---|---|---|---|---|
| **Field Data** | | | | | | | |
| Temp. °C | 18 | 18 | 16 | 14 | 12 | 4 | 0 |
| D.O. (mg/l) | 8.4 | 10.0 | 8.8 | 9.9 | 10.6 | 13.0 | 13.4 |
| pH (su) | 7.7 | 8.0 | - | 7.4 | 7.5 | 7.4 | 7.2 |
| **Bacteriological** | | | | | | | |
| MFFCC/100 ml | 20 | 10 | 40 | 80 | 40 | 50 | 10 |
| MFCC/100 ml | | | | 100 | 3300 | 1200 | 100 |
| **Lab Analysis Data** | | | | | | | |
| BOD, 5-day | 2.5 | 0.9 | 2.2 | 2.1 | 1.5 | 1.8 | 2.5 |
| Total Solids | 120 | 210 | | 96 | 108 | 90 | 90 |
| Suspended Solids | 16 | 23 | 16 | 8 | 6 | 3 | 4 |
| Volatile Suspended Solids | 5 | 11 | | 0 | 0 | 2 | 4 |
| Total Organic Nitrogen | | .31 | .47 | .28 | .40 | .05 | .15 |
| Nitrate Nitrogen | | .03 | .01 | .04 | .10 | .06 | .14 |
| Ammonia Nitrogen | | .03 | .01 | .04 | .05 | .05 | .08 |
| Nitrite Nitrogen | | .004 | .005 | .003 | - | .007 | .006 |
| Total Phosphorus | | .04 | .06 | .03 | .06 | .05 | .09 |
| Soluble Phosphorus | | .008 | - | - | - | .050 | .012 |
| Silica | | | | 8.1 | 8.2 | 7.6 | 10 |
| Total Iron | | .52 | 1.76 | .22 | .40 | 0.2 | .36 |
| Phenol | | | .01 | .005 | .01 | .01 | - |
| Manganese | | .05 | .04 | .04 | .045 | .04 | .04 |
| Chlorides | 1 | 0 | | 0 | 0 | 0 | 8 |
| Alkalinity Total ($CaCO_3$) | 56 | 52 | 56 | 58 | 54 | 58 | 60 |
| Hardness | 64 | 68 | | 60 | 64 | 53 | 64 |
| Conductivity micro/cm | | 146 | | 133 | 140 | 137 | 92 |
| Color | 35 | 30 | | 20 | 30 | 20 | 20 |
| Turbidity | | 5.8 | | 3.0 | 7.2 | 2.8 | 5.4 |
| pH (su) | 7.7 | 6.8 | 7.8 | 7.5 | 7.6 | 7.4 | 7.6 |

(Results in mg/l unless specified)

## SURFACE WATER QUALITY RECORD

Source: Brule River Highway 13 Year: 1974

| Date- | 1/24 | 2/18 | 3/14 | 4/16 | 4/18 | 4/21 | 4/23 | 4/25 | 6/4 | 6/20 | 7/22 | 9/4 | 9/10 | 10/4 | 10/17 | 11/21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field Data** | | | | | | | | | | | | | | | | |
| Temp. °C | 2 | 2 | 1 | 5 | 4 | 9 | 7 | 10 | 20 | 17 | 19 | 13 | 12 | 8.5 | 9 | 2 |
| D.O. (mg/1) | 12.1 | 13.0 | 13.5 | 12.9 | 13.7 | 11.9 | 12.5 | 11.6 | 9.5 | 8.8 | 10.1 | 10.9 | 11.6 | 12.0 | 11.0 | 13.3 |
| pH (su) | 7.3 | 7.5 | 7.7 | 7.2 | 7.0 | 7.8 | 7.0 | 7.1 | 7.8 | 7.6 | 8.0 | 7.8 | 7.6 | 7.4 | 7.4 | 7.3 |
| **Bacteriological** | | | | | | | | | | | | | | | | |
| MFFCC/100 ml | 10 | | 10 | 20 | 10 | 20 | 10 | 10 | 10 | 40 | 310 | 10 | 200 | 10 | 20 | 30 |
| MFCC/100 ml | 300 | | 200 | 170 | 1100 | 300 | 23000 | 200 | 1200 | 1200 | 7200 | 700 | 810 | 510 | 100 | 550 |
| **Lab Analysis Data** | | | | | | | | | | | | | | | | |
| BOD, 5-day | 1.5 | 1.6 | 0.9 | 4.1 | 3.3 | 1.2 | 1.6 | 1.6 | 3.1 | 2.5 | 2.5 | 1.6 | 1.2 | .6 | 4.5 | 1.2 |
| Total Solids | 102 | 100 | 112 | 116 | 140 | 100 | 106 | 112 | 98 | 98 | 118 | 98 | 78 | 96 | 86 | 82 |
| Suspended Solids | 18 | 7 | 15 | 56 | 70 | 35 | 20 | 28 | 13 | 20 | 25 | 6 | 10 | 8 | 5 | 1 |
| Volatile Suspended Solids | | 2 | 3 | 10 | 5 | 6 | 5 | 3 | 3 | 7 | 4 | 0 | 0 | 4 | 1 | 0 |
| Total Organic Nitrogen | .41 | .19 | .29 | .58 | .58 | .40 | .50 | .49 | .32 | .42 | .36 | .18 | | .46 | .17 | .19 |
| Nitrate Nitrogen | .15 | .15 | .29 | .11 | .11 | .04 | .07 | .08 | .09 | .12 | .04 | .14 | .02 | .02 | .04 | .10 |
| Ammonia Nitrogen | .10 | .02 | .06 | .05 | .10 | .05 | .06 | .07 | .06 | .11 | .02 | .02 | .19 | .03 | .01 | .06 |
| Nitrite Nitrogen | .004 | .003 | .006 | .007 | .007 | .007 | .007 | .009 | .005 | .005 | .004 | .006 | .001 | .001 | .002 | - |
| Total Phosphorus | .06 | .04 | .06 | .08 | .10 | .07 | .12 | .08 | .06 | .05 | .07 | .03 | .03 | .02 | .02 | .04 |
| Soluble Phosphorus | .024 | .014 | - | .014 | .016 | .02 | .016 | .034 | .020 | .010 | .021 | .010 | .014 | .006 | .009 | .025 |
| Silica | 11 | 10.2 | 9.6 | 9.6 | - | - | - | 9.4 | 8.0 | 11.2 | 10.8 | 11 | 11.8 | 11.6 | 11.8 | 12.2 |
| Total Iron | 0.5 | .24 | .66 | 2.0 | - | 1.36 | - | - | .46 | .70 | 1.06 | .24 | .22 | .20 | .20 | .42 |
| Phenol | .005 | - | .005 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .21 | .01 | .01 | .01 | .01 |
| Manganese | .04 | - | .04 | .04 | - | .04 | - | - | .05 | .05 | .05 | .04 | .04 | .04 | .04 | .04 |
| Chlorides | 0 | 2 | 2 | 1 | - | 1 | - | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 |
| Alkalinity Total ($CaCO_3$) | 58 | 48 | 59 | 30 | 28 | 36 | 32 | 40 | 52 | 50 | 58 | 60 | 56 | 54 | 56 | 52 |
| Hardness | 60 | 58 | 60 | 38 | 32 | 39 | 40 | 56 | 60 | 51 | 56 | 72 | 68 | 62 | 58 | 56 |
| Conductivity micro/cm | 1340 | 860 | 121 | 89 | - | 92 | - | - | 105 | 97 | 130 | 130 | 130 | 1320 | 220 | 113 |
| Color | 10 | 5 | 20 | 70 | - | 70 | - | - | 30 | 40 | 30 | 20 | 20 | 15 | 20 | 40 |
| Turbidity (su) | 6.2 | 4 | 12 | 14 | - | 20 | - | - | 5 | 6 | 16 | 3 | 2.3 | 1.7 | 2.5 | 7.2 |
| pH (su) | 7.1 | 7.4 | 7.7 | 7.2 | 7.0 | 7.4 | 7.3 | 7.3 | 6.9 | 7.8 | 7.8 | 7.9 | 7.9 | 7.5 | 7.9 | 7.8 |

| Date- | 1/24 | 2/18 | 3/14 | 4/16 | 4/18 | 4/21 | 4/23 | 4/25 | 6/4 | 6/20 | 7/22 | 9/4 | 9/10 | 10/4 | 10/17 | 11/21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COD | | 11 | | | | | | | | | | | | | | |
| Cyanide | | .01 | | | .01 | | | | | | .02 | | | | | |
| Fluoride | | .10 | | | .10 | | | | | | .10 | | | | | |
| Magnesium | | | | | 3 | | | | | | 5 | | | | | |
| Potassium | | | | | .8 | | | | | | 1.0 | | | | | |
| Sodium | | | | | 2.2 | | | | | | 2.7 | | | | | |
| Sulphate | | 4 | | | 2 | | | | | | 3 | | | | | |
| Calcium | | | | | 11 | | | | | | 14 | | | | | |
| **Metals (mg/l)** | | | | | | | | | | | | | | | | |
| Arsenic | | .02 | | | .02 | | | | | | - | | | | | |
| Barium | | .0265 | | | .029 | | | | | | - | | | | | |
| Cadmium | | .0001 | | | .002 | | | | | | .005 | | | | | |
| Chromium | | .0016 | | | .01 | | | | | | .01 | | | | | |
| Copper | | .0006 | | | .006 | | | | | | .006 | | | | | |
| Lead | | .002 | | | .02 | | | | | | .04 | | | | | |
| Mercury | | .0002 | | | .0002 | | | | | | .0002 | | | | | |
| Nickel | | .01 | | | .01 | | | | | | .006 | | | | | |
| Selenium | | .003 | | | .003 | | | | | | - | | | | | |
| Zinc | | .02 | | | .011 | | | | | | .02 | | | | | |
| **Organics (ppb)** | | | | | | | | | | | | | | | | |
| DDT | | .004 | | | .01 | | | | | | .01 | | | | | |
| DDD | | .004 | | | .005 | | | | | | .005 | | | | | |
| DDE | | .002 | | | .005 | | | | | | .005 | | | | | |
| PCB | | .04 | | | .02 | | | | | | .04 | | | | | |
| Aldrin | | .005 | | | .002 | | | | | | .002 | | | | | |
| Dieldrin | | .002 | | | .005 | | | | | | .005 | | | | | |
| Heptachlor | | .002 | | | .002 | | | | | | .002 | | | | | |
| Heptachlor Epoxide | | .002 | | | .002 | | | | | | .002 | | | | | |
| Lindane | | .001 | | | .002 | | | | | | .002 | | | | | |
| Methoxychlor | | .01 | | | .02 | | | | | | .002 | | | | | |
| Phthalate | | 0.2 | | | 0.2 | | | | | | 0.5 | | | | | |
| **Radiological** | | | | | | | | | | | | | | | | |
| Gross Alpha | | 2.5 | | | - | | | | | | 4.3 | | | | | |
| Gross Beta | | 2.5 | | | 3.5 | | | | | | 4.6 ±.8 | | | | | |
| $H^3$ | | 2361 | | | 410 | | | | | | | | | | | |
| $Sr^{90}$ | | 1.7 | | | 35 | | | | | | | | | | | |
| $Ra^{226}$ | | 2.1 | | | 2.5 | | | | | | | | | | | |

(Results in mg/l unless specified)

## SURFACE WATER QUALITY RECORD

**Source: Red River at Highway 2 Year: 1973**

| Date- | 2/5 | 2/27 | 3/20 | 4/23 | 5/29 | 6/27 | 7/31 | 9/5 | 9/25 | 10/25 | 11/20 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field Data** | | | | | | | | | | | | | | | | |
| Temp. °C | 0 | 0 | 0 | 10 | 15 | 21 | 20 | 20 | 14 | 12 | 4 | | | | | |
| D.O. (mg/1) | 11.6 | 11.9 | 13.1 | 9.4 | 8.7 | 7.2 | 7.2 | 7.0 | 9.7 | 9.3 | 13.0 | | | | | |
| pH (su) | 7.2 | 7.2 | 7.0 | 7.2 | 7.2 | 7.5 | 6.5 | 7.5 | 7.6 | 7.4 | 7.3 | | | | | |
| **Bacteriological** | | | | | | | | | | | | | | | | |
| MFFCC/100 ml | 15 | 5 | 5 | 10 | | 20 | 10 | 190 | 100 | 30 | 20 | | | | | |
| MFCC/100 ml | | 300 | | | | | | | 140 | 13000 | 900 | | | | | |
| **Lab Analysis Data** | | | | | | | | | | | | | | | | |
| BOD, 5-day | 2.5 | 2.5 | 1.5 | 3.7 | 1.8 | 1.8 | 4.3 | 0.9 | 2.9 | 2.4 | 1.5 | | | | | |
| Total Solids | 112 | 122 | 146 | 128 | 128 | 130 | 132 | | 126 | 122 | 106 | | | | | |
| Suspended Solids | 2 | 6 | 53 | 24 | 22 | 10 | 2.6 | 62 | 13 | 7 | 5 | | | | | |
| Volatile Suspended Solids | 0 | 2 | 2 | 2 | 1 | 3 | 13 | | 1 | 0 | 3 | | | | | |
| Total Organic Nitrogen | .26 | | .41 | | | | .46 | .63 | .37 | .54 | .16 | | | | | |
| Nitrate Nitrogen | .18 | | .12 | | | | .03 | .04 | .04 | .18 | .10 | | | | | |
| Ammonia Nitrogen | .10 | | .60 | | | | .03 | .01 | .05 | .07 | .06 | | | | | |
| Nitrite Nitrogen | | | .006 | | | | .004 | .007 | .004 | | .005 | | | | | |
| Total Phosphorus | .03 | | .06 | | | | .05 | .09 | .05 | .04 | .01 | | | | | |
| Soluble Phosphorus | | | .016 | | | | .016 | | | | .010 | | | | | |
| Silica | | | | | | | | 7.6 | 9.0 | 9.5 | 8.0 | | | | | |
| Total Iron | | | | | | | 1.14 | 3.8 | .50 | .66 | .60 | | | | | |
| Phenol | | | | | | | | .005 | .005 | .01 | .01 | | | | | |
| Manganese | | | | | | | .05 | .04 | .04 | .045 | .04 | | | | | |
| Chlorides | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | | | | | |
| Alkalinity Total ($CaCO_3$) | 64 | 74 | 29 | 36 | 34 | 74 | 56 | 68 | 70 | 70 | 72 | | | | | |
| Hardness | 72 | 76 | 46 | 40 | 40 | 72 | 68 | | 72 | 74 | 86 | | | | | |
| Conductivity micro/cm | | | | | | | 141 | 150 | 158 | 169 | 166 | | | | | |
| Color (su) | 40 | 40 | 100 | 100 | 120 | 50 | 70 | | 45 | 60 | 45 | | | | | |
| Turbidity | | | | | | | | 80 | 15 | 9.7 | 5.5 | | | | | |
| pH (su) | | | | | | | | | | | | | | | | |

(Results in mg/1 unless specified)

## SURFACE WATER QUALITY RECORD

**Source: Bad River at Highway 2 Year: 1974**

| Date- | 1/28 | 2/21 | 3/12 | 3/19 | 4/19 | 4/22 | 4/24 | 4/26 | 4/29 | 5/23 | 6/26 | 7/29 | 9/10 | 9/17 | 10/29 | 12/3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field Data** | | | | | | | | | | | | | | | | |
| Temp. °C | 0 | 1 | 1 | - | 5 | 6 | 5 | 11 | 14 | 17 | 22 | 23 | 14 | 13 | 10 | 1 |
| D.O. (mg/1) | - | 10.7 | 12.9 | - | 12.4 | 11.0 | 11.3 | 11.2 | 10.2 | 7.6 | 8.1 | 8.2 | 8.3 | 10.4 | 10.3 | 12.3 |
| pH (su) | 7.1 | 7.1 | 7.1 | - | 7.0 | 7.0 | 7.0 | 7.0 | 7.1 | 7.7 | 7.4 | 7.8 | 7.8 | 7.4 | 8.0 | 7.3 |
| **Bacteriological** | | | | | | | | | | | | | | | | |
| MFFCC/100 ml | 320 | 20 | 50 | - | 10 | 70 | 30 | 10 | 30 | 10 | 10 | 10 | 30 | 40 | 10 | 30 |
| MFCC/100 ml | 500 | 800 | 3600 | - | 400 | 1200 | 400 | 100 | 400 | 700 | 100 | 100 | 1400 | 300 | 240 | 350 |
| **Lab Analysis Data** | | | | | | | | | | | | | | | | |
| BOD, 5-day | 1.8 | 2.5 | 3.4 | - | 2.5 | 2.5 | 1.2 | 3.7 | 2.5 | 6.1 | 2.5 | 2.8 | 4 | 2 | 0.9 | |
| Total Solids | 144 | 118 | 132 | - | 242 | 342 | 232 | 162 | 120 | 122 | 102 | 112 | 164 | 138 | 122 | |
| Suspended Solids | 30 | - | 19 | - | 168 | 266 | 124 | 72 | 33 | 17 | 4 | 12 | 62 | 25 | 7 | |
| Volatile Suspended Solids | 8 | - | 3 | - | 16 | 13 | 8 | 0 | 1 | 3 | 0 | 2 | 4 | 0 | 1 | |
| Total Organic Nitrogen | .30 | .17 | - | .62 | .63 | .78 | .70 | .69 | .55 | .48 | .48 | .35 | .40 | .40 | .17 | |
| Nitrate Nitrogen | .11 | .07 | - | .15 | .24 | .12 | .13 | .12 | .06 | .05 | .01 | .11 | .10 | .05 | .02 | |
| Ammonia Nitrogen | .10 | .04 | - | .10 | .14 | .14 | .07 | .07 | .04 | .06 | .04 | .02 | .17 | .11 | .09 | |
| Nitrite Nitrogen | .005 | .005 | - | .009 | .008 | .008 | .009 | .011 | .005 | .004 | .005 | .003 | .008 | .006 | - | |
| Total Phosphorus | .03 | .03 | - | .05 | .15 | .21 | .15 | .10 | .06 | .04 | .03 | .04 | .07 | .04 | .04 | |
| Soluble Phosphorus | .014 | .018 | - | - | .02 | .024 | .036 | .024 | .018 | .012 | .010 | .020 | .021 | .015 | .016 | |
| Silica | 14 | 11.8 | - | 11.8 | 9.6 | - | 9.0 | 9.4 | 7.2 | 7.2 | 8.9 | 3.6 | 14 | 10.6 | 12 | |
| Total Iron | .78 | .38 | - | .94 | 4.0 | - | - | - | - | .85 | .64 | .54 | 2.5 | 1.88 | 2.5 | |
| Phenol | .005 | .005 | - | .005 | .01 | .01 | .01 | .02 | .01 | .01 | - | .01 | .01 | .01 | .01 | .02 |
| Manganese | .04 | .04 | - | .04 | .04 | - | - | - | - | .04 | .05 | .05 | .11 | .04 | .04 | |
| Chlorides | 3 | 1 | 3 | - | 1 | - | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | |
| Alkalinity Total ($CaCO_3$) | 79 | 78 | 58 | - | 22 | 2[illegible] | 20 | 22 | 20 | 56 | 70 | 78 | 78 | 52 | 76 | |
| Hardness | 80 | 80 | 72 | - | 30 | 28 | 28 | 28 | 38 | 56 | 68 | 81 | 116 | 56 | 80 | |
| Conductivity micro/cm | 180 | 158 | - | 145 | 83 | - | - | - | - | 115 | - | 170 | 170 | 120 | 160 | |
| Color (su) | 25 | 5 | 80 | - | 100 | - | - | - | 80 | 55 | 60 | 30 | 40 | 100 | 40 | |
| Turbidity (JTU) | 15 | 3.5 | 28 | - | 65 | - | - | - | - | 6.1 | 4.7 | 12 | 55 | 18 | 6.3 | |
| pH (su) | 7.3 | 7.6 | 7.6 | - | 7.5 | 7.0 | 7.0 | 7.3 | 7.2 | 7.2 | 8.0 | 8.1 | 7.6 | 7.6 | 7.9 | |

| Date- | 1/28 | 2/21 | 3/12 | 3/19 | 4/19 | 4/22 | 4/24 | 4/26 | 4/29 | 5/23 | 6/26 | 7/29 | 9/10 | 9/17 | 10/29 | 12/3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COD | | 10 | | | 34 | | | | | | | 16 | | | | |
| Cyanide | | .02 | | | .01 | | | | | | | | | | | |
| Fluoride | | .15 | | | .10 | | | | | | | .20 | | | | |
| Magnesium | | - | | | 2 | | | | | | | 6 | | | | |
| Potassium | | - | | | 1.3 | | | | | | | 1.0 | | | | |
| Sodium | | - | | | 1.7 | | | | | | | 3.3 | | | | |
| Sulphate | | 5.0 | | | 7.0 | | | | | | | 4 | | | | |
| Calcium | | - | | | 9 | | | | | | | 22 | | | | |
| **Metals (mg/l)** | | | | | | | | | | | | | | | | |
| Arsenic | | .02 | | | .02 | | | | | | | .002 | | | | |
| Barium | | .035 | | | .030 | | | | | | | .05 | | | | |
| Cadmium | | .0001 | | | .002 | | | | | | | .0003 | | | | |
| Chromium | | .0023 | | | .015 | | | | | | | .002 | | | | |
| Copper | | .0034 | | | .010 | | | | | | | .002 | | | | |
| Lead | | .002 | | | .02 | | | | | | | .003 | | | | |
| Mercury | | .0002 | | | .0002 | | | | | | | .0002 | | | | |
| Nickel | | .01 | | | .01 | | | | | | | .005 | | | | |
| Selenium | | .003 | | | .003 | | | | | | | .01 | | | | |
| Zinc | | .02 | | | .075 | | | | | | | .02 | | | | |
| **Organics (ppb)** | | | | | | | | | | | | | | | | |
| DDT | | .004 | | | .01 | | | | | | | .01 | | | | |
| DDD | | .004 | | | .005 | | | | | | | .005 | | | | |
| DDE | | .002 | | | .005 | | | | | | | .005 | | | | |
| PCB | | .04 | | | .02 | | | | | | | .04 | | | | |
| Aldrin | | .005 | | | .002 | | | | | | | .002 | | | | |
| Dieldrin | | .002 | | | .005 | | | | | | | .005 | | | | |
| Heptachlor | | .002 | | | .002 | | | | | | | .002 | | | | |
| Heptachlor Epoxide | | .002 | | | .002 | | | | | | | .002 | | | | |
| Lindane | | .001 | | | .002 | | | | | | | .002 | | | | |
| Methoxychlor | | .01 | | | .02 | | | | | | | .01 | | | | |
| Phthalete | | 0.2 | | | 0.2 | | | | | | | 0.2 | | | | |
| **Radiological** | | | | | | | | | | | | | | | | |
| Gross Alpha | | 1.1 | | | - | | | | | | | 1.3 | | | | |
| Gross Beta | | 2.9 | | | 6.7 | | | | | | | 5.1 | | | | |
| $H^3$ | | 367 | | | 400 | | | | | | | | | | | |
| $Sr^{90}$ | | | | | 2.1 $\pm$ 8 | | | | | | | | | | | |
| $Ra^{226}$ | | 112 | | | 2.5 | | | | | | | | | | | |

(Results in mg/l unless specified)

## SURFACE WATER QUALITY RECORD

Source: Montreal River at Highway 122 Year: 1973

| Date- | 2/5 | 2/27 | 3/20 | 4/23 | 5/29 | 6/27 | 7/31 | 9/5 | 9/25 | 10/29 | 11/20 | 12/13 | ___ | ___ | ___ | ___ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field Data** | | | | | | | | | | | | | | | | |
| Temp. °C | 0 | 0 | 1 | 9 | 16 | 20 | 19 | 21 | 15 | 9 | 4 | 1 | | | | |
| D.O. (mg/l) | 13.2 | 13.2 | 13.6 | 10.7 | 9.8 | 7.6 | 8.8 | 8.4 | 10.0 | 12.1 | 13.3 | 13.4 | | | | |
| pH (su) | 7.1 | 7.1 | 7.0 | 7.2 | 7.7 | 7.3 | 7.6 | 7.5 | 7.6 | 7.5 | 7.6 | 7.2 | | | | |
| **Bacteriological** | | | | | | | | | | | | | | | | |
| MFFCC/100 ml | 25 | 70 | 180 | 220 | | 210 | 40 | 110 | 90 | | 400 | 20 | | | | |
| MFCC/100 ml | 300 | 2300 | | | | | | | 3700 | | 2900 | 200 | | | | |
| **Lab Analysis Data** | | | | | | | | | | | | | | | | |
| BOD, 5-day | 3.7 | 2.8 | 1.5 | 3.7 | 1.8 | 2.5 | 0.9 | 1.8 | 2.5 | 1.5 | 1.5 | 0.9 | | | | |
| Total Solids | 90 | 104 | 92 | 66 | 104 | 100 | 92 | | 108 | 86 | 90 | 96 | | | | |
| Suspended Solids | 2 | 1 | 6 | 6 | 6 | 5 | 10 | 5 | 7 | 2 | 1 | 2 | | | | |
| Volatile Suspended Solids | 0 | 1 | 1 | 2 | 0 | 3 | 7 | | 1 | 2 | 1 | 2 | | | | |
| Total Organic Nitrogen | .54 | | .41 | | | | .57 | .66 | .59 | .62 | .54 | .62 | | | | |
| Nitrate Nitrogen | .07 | | .28 | | | | .09 | .16 | .14 | .20 | .23 | .24 | | | | |
| Ammonia Nitrogen | .24 | | .72 | | | | .05 | .01 | .05 | .13 | .10 | .14 | | | | |
| Nitrite Nitrogen | | | .007 | | | | .004 | .006 | .007 | .008 | .007 | .009 | | | | |
| Total Phosphorus | .08 | | .05 | | | | .07 | .09 | .07 | .08 | .21 | .06 | | | | |
| Soluble Phosphorus | | | .018 | | | | .023 | | | .06 | .05 | .04 | | | | |
| Silica | | | | | | | | 2.9 | 2.6 | 5.0 | 4.8 | 7.4 | | | | |
| Total Iron | | | | | | | .74 | .78 | .48 | .44 | .52 | .58 | | | | |
| Phenol | | | | | | | | .005 | .005 | .01 | .01 | .005 | | | | |
| Manganese | | | | | | | .05 | .04 | .04 | .02 | .04 | .04 | | | | |
| Chlorides | 2 | 3 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 2 | 4 | 4 | | | | |
| Alkalinity Total ($CaCO_3$) | 40 | 34 | 14 | 22 | 28 | 30 | 24 | 32 | 28 | 34 | 38 | 44 | | | | |
| Hardness | 48 | 40 | 33 | 30 | 36 | 36 | 32 | | 48 | 44 | 46 | 48 | | | | |
| Conductivity micro/cm | | | | | | | 83 | 88 | 106 | 115 | 116 | 130 | | | | |
| Color | 90 | 100 | 100 | 100 | 130 | 110 | 80 | | 60 | 80 | 70 | 70 | | | | |
| Turbidity | | | | | | | 2.4 | 2 | 3.5 | 2.5 | 1.8 | 2.2 | | | | |
| pH (su) | 7.3 | 7.0 | 6.5 | 7.2 | 7.3 | 7.2 | 6.6 | 7.4 | | 6.9 | 7.4 | 7.2 | | | | |

(Results in mg/l unless specified)

SURFACE WATER QUALITY RECORD

Source: Montreal River at Highway 122 Year: 1974

| Date- | 1/28 | 2/21 | 3/12 | 3/19 | 4/19 | 4/24 | 4/26 | 4/29 | 5/24 | 7/2 | 7/29 | 9/10 | 10/3 | 10/29 | 12/3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field Data** | | | | | | | | | | | | | | | | |
| Temp. °C | 0 | 1 | 1 | | 5 | 4 | 10 | 14 | 15 | 25 | 23.5 | 15.5 | 8 | 11.5 | 1 | |
| D.O. (mg/l) | | 13.0 | 13.5 | | 13.2 | 12.5 | 11.9 | 10.0 | 9.8 | 7.5 | 8.3 | 9.4 | 12.4 | 10.2 | 13.1 | |
| pH (su) | 7.1 | 7.2 | 7.1 | | 7.0 | 7.0 | 7.0 | 7.2 | 7.8 | 7.7 | 7.2 | 7.8 | 7.0 | 7.2 | 7.2 | |
| **Bacteriological** | | | | | | | | | | | | | | | | |
| MFFCC/100 ml | 10 | 10 | 10 | | 230 | 360 | 590 | 220 | 50 | 10 | 10 | 80 | 50 | 10 | 240 | |
| MFEC/100 ml | 300 | 7600 | 100 | | 5200 | 3200 | 2600 | 3700 | 2400 | 1900 | 600 | 2900 | 540 | 10 | 1400 | |
| **Lab Analysis** | | | | | | | | | | | | | | | | |
| BOD, 5-day | 1.8 | 2.0 | 2.5 | | 2.9 | 1.6 | 4.1 | 3.3 | 2.8 | 2.5 | 3.1 | 4.1 | 2.5 | 1.2 | 1.5 | |
| Total Solids | 106 | 104 | 102 | | 72 | 68 | 72 | 76 | 104 | 84 | 68 | 70 | 72 | 80 | 88 | |
| Suspended Solids | 13 | 1 | 5 | | 18 | 18 | 4 | 8 | 11 | 4 | 1 | 5 | 2 | 1 | 4 | |
| Volatile Suspended Solids | 5 | 1 | 3 | | 4 | 3 | 0 | 2 | 2 | 4 | 1 | 0 | 2 | 0 | 2 | |
| Total Organic Nitrogen | .49 | .48 | | .62 | .46 | .58 | .62 | .59 | .72 | .53 | .57 | .60 | .45 | .42 | .10 | |
| Nitrate Nitrogen | .24 | .09 | | .27 | .27 | .14 | .11 | .08 | .11 | .14 | .10 | .16 | .16 | .18 | .27 | |
| Ammonia Nitrogen | .16 | .19 | | .19 | .10 | .10 | .08 | .05 | .07 | .07 | .01 | .03 | .07 | .14 | .10 | |
| Nitrite Nitrogen | .011 | .01 | | .01 | .008 | .005 | .009 | .006 | .009 | .006 | .004 | .002 | | | | |
| Total Phosphorus | .09 | .15 | | .08 | .07 | .08 | .06 | .06 | .10 | .09 | .09 | .08 | .07 | .07 | .07 | |
| Soluble Phosphorus | .064 | .06 | | | .01 | .038 | .020 | .028 | .048 | .042 | .048 | .041 | .043 | .037 | .033 | |
| Silica | 8.8 | 7.8 | | 2.4 | 7.2 | 6.8 | 7.0 | 3.8 | 6.6 | 4.2 | 1.6 | 4.4 | 4.6 | 5.6 | 1.0 | |
| Total Iron | .50 | .68 | | .82 | .46 | | | | .64 | .32 | .5 | .6 | .52 | .48 | .6 | |
| Phenol | .005 | .005 | | .005 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | - | .02 | |
| Manganese | .04 | .04 | | .04 | .04 | | | | .04 | .05 | .05 | .70 | | .04 | .04 | |
| Chlorides | 1 | 3 | 6 | | 1 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 3 | 1 | 4 | |
| Alkalinity Total ($CaCO_3$) | 38 | 34 | 36 | | 14 | 10 | 20 | 20 | 39 | 28 | 36 | 22 | 28 | 26 | 38 | |
| Hardness | 46 | 40 | 56 | | 23 | 20 | 24 | 32 | 44 | 32 | 33 | 34 | 38 | 34 | 53 | |
| Conductivity micro/cm | 110 | 86 | | 120 | 59 | | | | 88 | 71 | 79 | 75 | 77.5 | 76 | 110 | |
| Color | 80 | 35 | 60 | | 60 | | | 80 | 100 | 70 | 60 | 60 | 40 | 80 | 90 | |
| Turbidity | 2.3 | 2.4 | 4.4 | | 7.1 | | | | 3.5 | 2 | | 2.7 | 1.2 | 2 | 1.7 | |
| pH (su) | 7.0 | 7.2 | 7.3 | | 7.0 | 6.7 | 7.1 | 7.2 | 7.7 | 7.05 | 7.5 | 7.1 | 6.75 | 7.3 | 7.6 | |

| Date- | 1/28 | 2/21 | 3/12 | 3/19 | 4/19 | 4/24 | 4/26 | 4/29 | 5/24 | 7/2 | 7/29 | 9/10 | 10/3 | 10/29 | 12/3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COD | | 45 | | | 26 | | | | | | 31 | | | | | |
| Cyanide | | .01 | | | .01 | | | | | | .03 | | | | | |
| Fluoride | | .10 | | | .15 | | | | | | .10 | | | | | |
| Magnesium | | | | | 1 | | | | | | 2 | | | | | |
| Potassium | | | | | | | | | | | .85 | | | | | |
| Sodium | | | | | | | | | | | 2.1 | | | | | |
| Sulphate | | 3.0 | | | 3.0 | | | | | | 4 | | | | | |
| Calcium | | | | | 7 | | | | | | 10 | | | | | |
| **Metals (mg/l)** | | | | | | | | | | | | | | | | |
| Arsenic | | .02 | | | .02 | | | | | | .002 | | | | | |
| Barium | | .013 | | | .01 | | | | | | .009 | | | | | |
| Cadmium | | .0001 | | | .002 | | | | | | .0003 | | | | | |
| Chromium | | .0014 | | | .01 | | | | | | .002 | | | | | |
| Copper | | .0013 | | | .077 | | | | | | .002 | | | | | |
| Lead | | .002 | | | .02 | | | | | | .003 | | | | | |
| Mercury | | .0002 | | | .0002 | | | | | | .0002 | | | | | |
| Nickel | | .01 | | | .01 | | | | | | .005 | | | | | |
| Selenium | | .003 | | | .003 | | | | | | .01 | | | | | |
| Zinc | | .02 | | | .015 | | | | | | .02 | | | | | |
| **Organics (ppb)** | | | | | | | | | | | | | | | | |
| DDT | | | | | | | | | | | | | | | | |
| DDD | | .004 | | | .005 | | | | | | .005 | | | | | |
| DDE | | .002 | | | .005 | | | | | | .005 | | | | | |
| PCB | | .04 | | | .02 | | | | | | .04 | | | | | |
| Aldrin | | .005 | | | .002 | | | | | | .002 | | | | | |
| Dieldrin | | .002 | | | .005 | | | | | | .005 | | | | | |
| Heptachlor | | .002 | | | .002 | | | | | | .002 | | | | | |
| Heptachlor Epoxide | | .002 | | | .002 | | | | | | .002 | | | | | |
| Lindane | | .001 | | | .002 | | | | | | .002 | | | | | |
| Methoxychlor | | .01 | | | .02 | | | | | | .01 | | | | | |
| Phthalate | | 0.2 | | | 0.2 | | | | | | 0.2 | | | | | |
| **Radiological** | | | | | | | | | | | | | | | | |
| Gross Alpha | | 2.5 | | | | | | | | | 2.0 ± .7 | | | | | |
| Gross Beta | | 2.5 | | | 2.5 | | | | | | 8.7 ± .9 | | | | | |
| $H^3$ | | 367 | | | 400 | | | | | | | | | | | |
| $Sr^{90}$ | | | | | 2.5 | | | | | | | | | | | |
| $Ra^{226}$ | | 1.2 | | | 2.5 | | | | | | | | | | | |

(Results in mg/l unless specified)

# APPENDIX B

## 1975 DATA SUMMARIES

1975 MONITORING DATA - NEMADJI RIVER NEAR SUPERIOR

Station: 16003

| Parameter | Date | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2/12 | 4/3 | 4/17 | 4/21 | 4/24 | 5/7 | 6/12 |
| Water Temp. (cent) | 0 | 1 | .5 | 4 | 5.5 | 11 | 12 |
| pH (su) | 7.2 | 7.4 | 7.4 | 7.3 | 7.5 | 7.2 | 7.8 |
| BOD, 5-day (mg/1) | 2.1 | 1.5 | 2.1 | | 2.1 | 2.1 | 2.5 |
| Lab pH (su) | 7.4 | 7.3 | 7.0 | 7.3 | 7.1 | 7.3 | 7.8 |
| Residue, Total (mg/1) | 150 | 174 | 632 | 564 | 614 | 246 | 218 |
| Residue, Tot Nflt (mg/1) | 6 | 10 | 542 | 464 | 512 | 140 | 58 |
| Residue, Vol Nflt (mg/1) | 6 | 2 | 42 | 32 | 28 | 12 | 9 |
| Phos-Tot (mg/1) | .02 | .50 | .27 | .31 | .41 | .11 | .05 |
| Phos-Dis Ortho (mg/1 P) | .011 | .018 | .03 | .054 | .074 | .036 | .023 |
| Org N N (mg/1) | .72 | .46 | .54 | .80 | .71 | .22 | .05 |
| $NH_3$-N Total (mg/1) | .14 | .10 | .20 | .17 | .09 | .41 | |
| $NO_2$ & $NO_3$ N-Total (mg/1) | .27 | .27 | .21 | .22 | .14 | .07 | .06 |
| T Alk $CaCO_3$ (mg/1) | 104 | 82 | 52 | 42 | 41 | 48 | 102 |
| Chloride Cl (mg/1) | 3 | 3 | 2 | 0 | 0 | 0 | 1 |
| Color PT-CO | 60 | 140 | 140 | 140 | 140 | 140 | 70 |
| Conductivity at 25°C (micromho) | 238 | 210 | 143 | 113 | 140 | 119 | 238 |
| Total Hard $CACO_3$ (mg/1) | 108 | 97 | 57 | 45 | 55 | 58 | 110 |
| Turbidity (FTU) | 7 | 25 | 230 | 170 | 180 | 66 | 35 |
| Silica Total (mg/1) | 17 | 14.3 | 7.8 | 7.8 | 7.0 | 6.5 | 10.8 |
| Iron Fe (mg/1) | .44 | 2 | 13.8 | 13.5 | 14.5 | 5.2 | |
| Manganese Mn (ug/1) | .04 | .04 | .26 | .24 | .22 | .09 | |
| Fec Coli (m-fc agar/100 ml) | 10 | | 110 | 30 | 20 | | |
| Phenols (ug/1) | .04 | | .023 | .002 | .001 | | |
| Tot Coli (mfimendo,100 ml) | 100 | | 2900 | 600 | 500 | | 170 |
| Cyanide Cn (mg/1 | | | | .01 | | | |
| COD Hi Level (mg/1) | | | | 66 | | | |
| Cadmium Cd Tot (ug/1) | | | | .0005 | | | |
| Chromium Cr Tot (ug/1) | | | | .003 | | | |
| Copper Cu Tot (ug/1) | | | | .007 | | | |
| Lead Pb Tot (ug/1) | | | | 1.2 | | | |
| Mercury Hg Tot (ug/1) | | | | .0002 | | | |
| Nickel Ni Tot (ug/1) | | | | .02 | | | |

| Parameter | Date | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2/12 | 4/3 | 4/17 | 4/21 | 4/24 | 5/7 | 6/12 |
| Zinc Zn Tot (ug/1) | | | | .05 | | | |
| Residue Tot Vol (mg/1) | | | | 68 | 74 | | |
| Calcium Ca Tot (mg/1) | | | | 15 | | | |
| Magnesium Mg Tot (mg/1) | | | | 2 | | | |
| Potassium K Tot (mg/1) | | | | 2 | | | |
| Sodium Na Tot (mg/1) | | | | 2 | | | |
| Sulfate $SO_4$ Tot (mg/1) | | | | 1 | | | |
| Fluoride F Tot (mg/1) | | | | .2 | | | |
| BOD, 6-day (mg/1) | | | | 3.4 | | | |
| Flow (cfs) | 78 | 210a | 3600a | 3500a | 4700a | | |
| Dissolved Oxygen | | | | | | | 9.3 |

a - Data is provisional

1975 MONITORING DATA - BOIS BRULE RIVER NEAR PORT WING

Station: 163002

| Parameter | Date 2/12 | 4/3 | 4/17 | 4/21 | 4/24 | 5/7 | 6/12 |
|---|---|---|---|---|---|---|---|
| Water Temp (cent) | 1 | 1 | 4 | 6 | 5 | 11 | 12 |
| pH (su) | 7.2 | 7.4 | 7.2 | 7.2 | 7.1 | 7.1 | 7.4 |
| BOD, 5-day (mg/1) | 2.1 | 1.8 | 1.5 | | 1.5 | 2.1 | 2.8 |
| Lab pH (su) | 7.3 | 7.3 | 6.9 | 6.9 | 6.6 | 7.5 | 7.7 |
| Residue Total (mg/1) | 80 | 104 | 138 | 120 | 114 | | 122 |
| Residue Total Nflt (mg/1) | 13 | 16 | 53 | 34 | 38 | 30 | 26 |
| Residue Vol Nflt (mg/1) | 6 | 4 | 8 | 4 | 4 | 6 | 4 |
| Phos Tot (mg/1) | .03 | .05 | .09 | .11 | .07 | .06 | .05 |
| Phos Dis Ortho (mg/1 P) | .017 | .01 | .031 | .073 | .013 | .032 | .027 |
| Org N N (mg/1) | .67 | .15 | .53 | .47 | .33 | .17 | .34 |
| $NH_3N$ Total (mg/1) | .19 | .05 | .09 | .06 | .04 | .22 | .04 |
| $NO_2$ & $NO_3$ Total (mg/1) | .12 | .07 | .17 | .11 | .02 | .07 | .06 |
| T Alk $CaCO_3$ (mg/1) | 58 | 56 | 34 | 30 | 28 | 46 | 60 |
| Chloride Cl (mg/1) | 1 | 0 | 1 | 1 | 0 | 0 | 1 |
| Color PT-CO | 30 | 35 | 90 | 90 | 80 | 70 | 30 |
| Conductivity at 25°C (micromho) | 127 | 131 | 92 | 86 | 77 | 102 | 143 |
| Total Hardness $CACO_3$ (mg/1) | 64 | 56 | 36 | 34 | 35 | 48 | 60 |
| Turbidity (FTU) | 4.6 | 5.1 | 32 | 19 | 17 | 15 | 15 |
| Silica Total (mg/1) | 14 | 12.5 | 9.5 | 9.3 | 8.5 | 93 | 12.3 |
| Iron Fe (mg/1) | .36 | .48 | 2.32 | .14 | | | |
| Manganese Mn (ug/1) | | .04 | .05 | .04 | .04 | .04 | 50 |
| Fec Coli (m-fc agar/100 ml) | | | 20 | | | | 420 |
| Phenols (mg/1) | .01 | .018 | .001 | | .005 | | |
| Cyanide Cn (mg/1) | | | | .01 | | | |
| Tot Coli (mfimendo/100 ml) | | | 420 | | 100 | | |
| COD Hi Level (mg/1) | | | | 43 | | | |
| Zinc Zn Total (ug/1) | | | | .05 | | | |
| Residue Total Vol (mg/1) | | | | 44 | 48 | | |
| Fec Coli (m-fc agar/100 ml) | | | | | 10 | | |
| Iron Fe (mg/1) | | | | | 1.5 | 1.08 | .36 |
| Flow (cfs) | 140 | 155 | 269 | 432 | 478 | | |
| Calcium Ca Total (mg/1) | | | | 8 | | | |
| Magnesium Mg Total (mg/1) | | | | 3 | | | |
| Potassium K Total (mg/1) | | | | 1 | | | |
| Sodium Na Total (mg/1) | | | | 2 | | | |
| Sulfate SO4 Total (mg/1) | | | | 4 | | | |
| Fluoride F Total (mg/1) | | | | .25 | | | |
| BOD, 6-day (mg/1) | | | | 3.1 | | | |
| Dissolved Oxygen (mg/1) | | | | | | | 9.6 |

1975 MONITORING DATA - MONTREAL RIVER NEAR SAXON

Station: 263001

| Parameter | Date 1/30 | 2/24 | 4/17 | 4/21 | 4/24 | 5/7 | 5/8 | 6/13 |
|---|---|---|---|---|---|---|---|---|
| Water temp (cent) | 1 | 1 | 1 | 5 | 4 | 12.5 | 12.5 | 15 |
| pH (su) | 7 | 7.4 | 7.1 | 7.1 | 7.1 | 6.8 | 6.8 | 7.4 |
| BOD, 5-day (mg/l) | 2.1 | 1.2 | 1.8 | | | | 2.8 | |
| Lab pH (su) | 7 | 7 | 6.6 | 6.8 | | | 7 | |
| Residue Total (mg/l) | 112 | 86 | 100 | 74 | | | 76 | |
| Residue Total Nflt (mg/l) | 5 | 7 | 27 | 10 | | | 3 | |
| Residue Vol Nflt (mg/l) | 5 | 0 | 6 | 2 | | | 0 | |
| Phos Total (mg/l) | .07 | .07 | .08 | .05 | | | .05 | |
| Phos Dis Ortho (mg/l P) | .042 | .045 | .02 | .023 | | | .032 | |
| Org N N (mg/l) | .22 | .32 | .36 | .42 | | | .34 | |
| $NH_3N$ Total (mg/l) | .45 | .13 | .47 | .07 | | | .05 | |
| $NO_2$ & $NO_3$ Total (mg/l) | .27 | .27 | .32 | .25 | | | .12 | |
| T Alk $CaCO_3$ (mg/l) | 24 | 32 | 22 | 17 | | | 28 | |
| Chloride Cl (mg/l) | 4 | 3 | 3 | 1 | | | 2 | |
| Color PT-CO | 80 | 80 | 80 | 80 | | | 80 | |
| Conductivity at 25°C (micromho) | 108 | 96 | 85 | 65 | | | 82 | |
| Total Hardness $CACO_3$ (mg/l) | 40 | 40 | 30 | 22 | | | 36 | |
| Turbidity (FTU) | 1.4 | 1.6 | 14 | 6 | | | 2.3 | |
| Silica Total (mg/l) | 8.8 | 8.8 | 7.8 | 6 | | | 4.5 | |
| Iron Fe (mg/l) | .6 | .64 | 10.4 | .48 | .68 | .44 | .55 | |
| Manganese Mn (ug/l) | .06 | .04 | .08 | .04 | .04 | .05 | | 90 |
| Fec Coli (m-fc agar/100 ml) | 130 | | 1500 | | | | | |
| Phenols (mg/l) | .02 | .02 | .015 | .001 | .001 | | | 1 |
| Dissolved Oxygen (mg/l) | | | | | | | | 9 |
| Calcium Ca Total (mg/l) | | | | 6 | | | | |
| Magnesium Mg Total (mg/l) | | | | 2 | | | | |
| Potassium K Total (mg/l) | | | | 1 | | | | |
| Sodium Na Total (mg/l) | | | | 2 | | | | |
| Sulfate $SO_4$ Total (mg/l) | | | | 5 | | | | |
| Fluoride F Total (mg/l) | | | | .25 | | | | |
| BOD, 6-day (mg/l) | | | | 2.5 | | | | |
| Residue Total Vol (mg/l) | | | | 42 | | | | |
| DDT (ug/l) | | | | .01 | | | | |
| DDE (ug/l) | | | | .005 | | | | |
| DDD (ug/l) | | | | .005 | | | | |
| Aldrin (ug/l) | | | | .002 | | | | |

| Parameter | 1/30 | 2/24 | 4/17 | 4/21 | 4/24 | 5/7 | 5/8 | 6/13 |
|---|---|---|---|---|---|---|---|---|
| Heptachlor (ug/1) | | | | .002 | | | | |
| Lindane (ug/1) | | | | .002 | | | | |
| Heptachlor Epoxide (ug/1) | | | | .002 | | | | |
| Tot Coli MFIMENDO (/100 ml) | 730 | | 17000 | | | | | |
| Cadmium Cd Total (ug/1) | | | | .0002 | | | | |
| Chromium Cr Total (ug/1) | | | | .003 | | | | |
| Copper Cu Total (ug/1) | | | | .003 | | | | |
| Lead Pb Total (ug/1) | | | | .003 | | | | |
| Mercury Hg Total (ug/1) | | | | .0002 | | | | |
| Nickel Ni Total (ug/1) | | | | .02 | | | | |
| Zinc Zn Total (ug/1) | | | | .05 | | | | |
| Cyanide Cn (mg/1) | | | | .01 | | | | |
| COD Hi Level (mg/1) | | | | 35 | | | | |
| Flow (cfs) | 196 | 223 | 970 | 654 | 2382 | | | |

## 1975 MONITORING DATA - BAD RIVER AT ODANAH

Station: 023001

| Parameter | Date 1/30 | 2/24 | 4/14 | 4/17 | 4/21 | 4/24 | 5/7 | 5/8 | 6/13 |
|---|---|---|---|---|---|---|---|---|---|
| Water Temp (cent) | 0 | 1 | | 3 | 4.5 | 4.5 | 12 | 12 | 15.5 |
| pH (su) | 7.2 | 7.4 | | 7.1 | 7.0 | 7.0 | 7.1 | 7.1 | 7.6 |
| BOD, 5-day (mg/l) | 1.8 | | | 3.1 | | 3.1 | 2.1 | | 3.1 |
| Lab pH (su) | 7.6 | 7.6 | | 6.8 | 6.9 | 6.6 | 7.2 | | 7.7 |
| Residue Total (mg/l) | 134 | 220 | | 520 | 262 | 458 | 118 | | 136 |
| Residue Total Nflt (mg/l) | 10 | 17 | | 428 | 172 | 382 | 32 | | 7 |
| Residue Vol Nflt (mg/l) | 6 | 3 | | 30 | 10 | 16 | 2 | | 1 |
| Phos Tot (mg/l) | .03 | .06 | | .30 | .14 | .25 | .04 | | .03 |
| Phos Dis Ortho (mg/l P) | .009 | .034 | | .03 | .095 | .035 | .027 | | .011 |
| Org N N (mg/l) | .07 | .22 | | .65 | .69 | .62 | .28 | | .25 |
| $NH_3N$ Total (mg/l) | .23 | .05 | | .27 | .08 | .07 | .06 | | .01 |
| $NO_2$ & $NO_3$ Total (mg/l) | .21 | .40 | | .21 | .20 | .12 | .05 | | .04 |
| T Alk $CACO_3$ | 70 | 98 | | 32 | 22 | 24 | 39 | | 82 |
| Chloride Cl (mg/l) | 1 | 45 | | 1 | 0 | 0 | 2 | | 1 |
| Color PT-CO | 40 | 30 | | 140 | 140 | 140 | 80 | | 30 |
| Conductivity at 25°C (micromho) | 156 | 334 | | 89 | 71 | 69 | 110 | | 175 |
| Total Hardness $CaCO_3$ (mg/l) | 73 | 100 | | 37 | 29 | 30 | 52 | | 82 |
| Turbidity (FTU) | 4.8 | 7.1 | | 130 | 62 | 96 | 16 | | 7.5 |
| Silica Total (mg/l) | 15 | 21.5 | | 8.3 | 8 | 7.5 | 7.3 | | 10 |
| Iron Fe (mg/l) | .52 | .64 | | 11 | 3.6 | 7.5 | | 3.4 | .3 |
| Manganese Mn (ug/l) | .04 | .04 | | .18 | .07 | .11 | | .07 | |
| Fec Coli (m-fc agar/100 ml) | | 10 | | 40 | | 100 | | | 20 |
| Phenols (ug/l) | | .001 | | .002 | .001 | .001 | | | 1 |
| Tot Coli MFIMENDO (/100 ml) | | 260 | | | | | | | |
| Cyanide Cn (mg/l) | | | | | .01 | | | | |
| COD Hi Level (mg/l) | | | | | 41 | | | | |
| Cadmium Cd (ug/l) | | | | | .0002 | | | | |
| Chromium Cr Tot (ug/l) | | | | | .003 | | | | |
| Copper Cu Tot (ug/l) | | | | | .003 | | | | |
| Lead Pb Tot (ug/l) | | | | | .19 | | | | |
| Mercury Hg Tot (ug/l) | | | | | .0002 | | | | |
| Nickel Ni Tot (ug/l) | | | | | .02 | | | | |
| Zinc Zn Tot (ug/l) | | | | | .05 | | | | |
| Residue Tot Vol (mg/l) | | | | | 52 | 58 | | | |
| Calcium Ca Tot (mg/l) | | | | | 8 | | | | |

| Parameter | 1/30 | 2/24 | 4/14 | 4/17 | 4/21 | 4/24 | 5/7 | 5/8 | 6/13 |
|---|---|---|---|---|---|---|---|---|---|
| Magnesium Mg Tot (mg/1) | | | | | | | | | |
| Potassium K Tot (mg/1) | | | | | 2 | | | | |
| Sodium Na Tot (mg/1) | | | | | 1 | | | | |
| Sulfate $SO_4$ Tot (mg/1) | | | | | 1 | | | | |
| Fluoride F Tot (mg/1) | | | | | 5 | | | | |
| DDT (ug/1) | | | | | .25 | | | | |
| DDE (ug/1) | | | | | .01 | | | | |
| DDD (ug/1) | | | | | .005 | | | | |
| Aldrin (ug/1) | | | | | .005 | | | | |
| Heptachlor (ug/1) | | | | | .002 | | | | |
| Lindane (ug/1) | | | | | .002 | | | | |
| Heptachlor Epoxide (ug/1) | | | | | .002 | | | | |
| Dieldrin (ug/1) | | | | | .002 | | | | |
| Methoxychlor (ug/1) | | | | | .005 | | | | |
| PCBs (ug/1) | | | | | .02 | | | | |
| DEHP (ug/1) | | | | | .04 | | | | |
| Oil & Grease (mg/1) | | | | | .02 | | | | |
| Flow (cfs) | 260 | 230 | 2000 | 3520 | 3660 | 6330 | | | |
| BOD, 6-day (mg/1) | | | | | 3.4 | | | | |
| Dissolved Oxygen (mg/1) | | | | | | | | | 8.5 |

## APPENDIX C

### River Flows Near Monitoring Stations (cfs)

| Date | Nemadji[1] | Bois Brule[2] | Bad[3] | Montreal[4] | Date | Nemadji | Bois Brule | Bad | Montreal |
|---|---|---|---|---|---|---|---|---|---|
| 2/05/73 | | | 330 | 189 | 4/16/74 | | 335 | | |
| 2/27/73 | | | 240 | 215 | 4/18/74 | 3100 | 412 | | |
| 3/20/73 | | | 2160 | 211 | 4/19/74 | | | 3860 | 1720 |
| 4/23/73 | | | 1180 | 911 | 4/21/74 | 2400 | 355 | | |
| 5/29/73 | | | 1110 | 372 | 4/22/74 | | | 4990 | |
| 6/27/73 | | 163 | 352 | 504 | 4/23/74 | 1800 | 347 | | |
| 7/03/73 | | | | | 4/24/74 | | | 3070 | 1696 |
| 7/31/73 | | 133 | 376 | 242 | 4/25/74 | 1000 | 303 | | |
| 9/05/73 | | 183 | 447 | 234 | 4/26/74 | | | 1890 | 931 |
| 9/25/73 | | 146 | 262 | 183 | 4/29/74 | | | 1390 | 802 |
| 10/25/73 | | 177 | 243 | | 5/23/74 | | | 605 | |
| 10/29/73 | | | | 185 | 5/24/74 | | | | 286 |
| 11/20/73 | | 165 | 286 | 161 | 6/04/74 | 190 | 193 | | |
| 12/13/73 | | | | 100 | 6/18/74 | 387 | | | |
| 12/17/73 | | 150 | | | 6/20/74 | | 232 | | |
| 1/24/74 | | 140 | | | 6/26/74 | | | 292 | |
| 1/28/74 | 74 | | 190 | | 6/27/74 | | | | |
| 2/12/74 | | | | | 7/02/74 | | | | 200 |
| 2/14/74 | 72 | | | | 7/22/74 | 157 | 167 | | |
| 2/18/75 | | 140 | | | 7/29/74 | | | 143 | 183 |
| 2/21/74 | | | 190 | 161 | 9/03/74 | 69 | | | |
| 3/12/74 | | | 540 | 195 | 9/04/74 | | 135 | | |
| 3/14/75 | 210 | 141 | | | 9/10/74 | | 143 | 425 | 279 |
| 3/19/74 | | | 310 | | 9/11/74 | 67 | | | |
| 4/10/74 | 1000 | | | | 9/13/74 | | | | |

[1] Nemadji River total stream drainage area = 475 square miles. To determine stream flows and loading to Lake Superior multiply by a factor of 1.13. The Wisconsin drainage area is 215 square miles or 0.45 of the total, with the remainder being in Minnesota. The gaging station is near South Superior.

[2] Bois Brule River total stream drainage area = 190.2 square miles. To determine stream flows and loading to Lake Superior multiply by a factor of 1.59. The flow gaging station is near Brule.

[3] Bad River total stream drainage area = 1,092 square miles. To determine stream flows and loading to Lake Superior multiply by a factor of 1.79. The flow gaging station is near Odanah.

[4] Montreal River total stream drainage area = 277.3 square miles. To determine stream flows and loadings to Lake Superior multiply by a factor of 1.05. The Wisconsin drainage area is 180 square miles or 0.65 of the total - the remainder is in Michigan. Flows listed are at the Superior Falls hydropower plant.

| Date | Nemadji | Bois Brule | Bad | Montreal |
|---|---|---|---|---|
| 9/16/74 | | 137 | | |
| 9/17/74 | | | 334 | |
| 9/18/74 | | | 287 | |
| 10/03/74 | | | | 206* |
| 10/04/74 | 57* | 129* | | |
| 10/17/74 | | 138* | | |
| 10/29/74 | | | 216* | 192* |
| 11/13/74 | 246* | | | |
| 11/21/74 | | 163* | | |
| 12/03/74 | | | 390* | |
| 1/30/75 | | | 260 | 196 |
| 2/12/75 | 78 | 140 | | |
| 2/24/75 | | | 230 | 223 |
| 4/03/75 | 210* | 155 | | |
| 4/14/75 | | | 2000 | |
| 4/17/75 | 3600* | 269 | 3520 | 970 |
| 4/21/75 | 3500* | 432 | 3660 | 654 |
| 4/24/75 | 4700* | 478 | 6330 | 2382 |
| 5/07/75 | 825* | 299 | | |
| 5/08/75 | | | 907 | |
| 6/12/75 | 110* | 190 | 252 | 200 |
| 6/13/75 | | | | 197 |

*Data is provisional